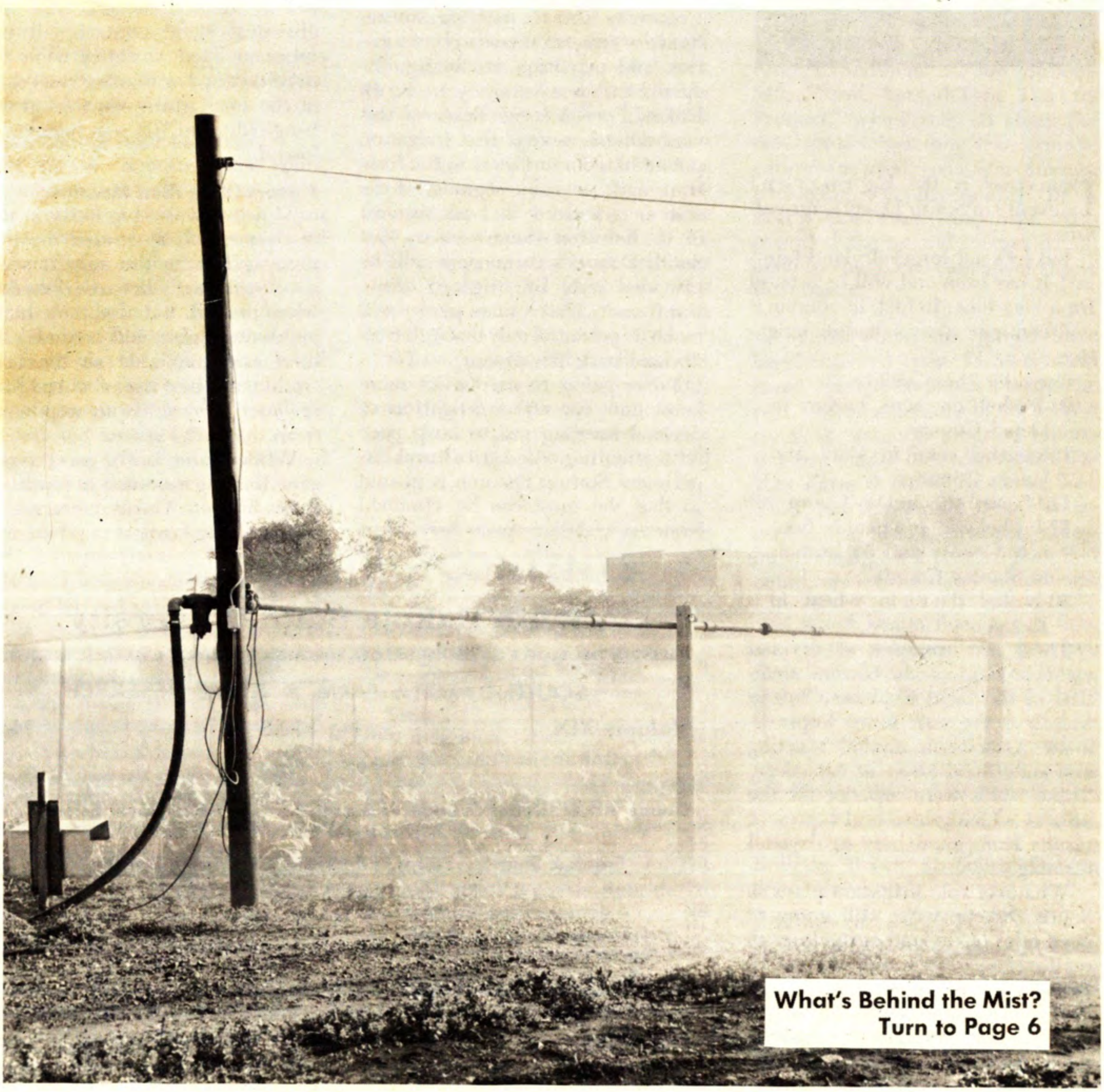
Spring 1968

South Dakota Farm and Home Research

Agricultural Experiment Station, South Dakota State University

Volume XIX No. 2 Spring 1968 / SOUTH DAKOTA

Farm & Home Research



What's Behind the Mist?
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AGRICULTURAL EXPERIMENT STATION ☐ SOUTH DAKOTA STATE UNIVERSITY, BROOKINGS

From the Dean and Director

We're Not Forgetting Dryland Farming

IRRIGATION is the big current "event" in South Dakota agriculture.

But let's not forget dryland farming. It has been and will be around for a long time. In fact, in volume it will continue to overshadow irrigation.

Consider these yields:

- 93-bushel an acre barley in Deuel County.
- 155-bushel corn in Clay and Union Counties.
- 110-bushel oats in Day County.
- 77-bushel winter wheat in Bennett County and 54 bushels in Stanley County.
- 50-bushel durum wheat in Kingsbury County.

Those are examples of dryland yields by farmers who became members of the Yield Explorer Club in March at the state Crop Improvement Association annual meeting and state Seed Show at Aberdeen. These yields were superior for the area in which grown and represent results from know-how in dryland farming.

Whatever role irrigation plays in South Dakota, we're still going to need a lot of dryland agriculture to realize the state's full potential. Reasons are varied and many: limited suitable topography for irrigation, soil types, availability of water, labor, capital, . . . and don't forget, some people just won't want to go into irrigation.

Both Irrigation, Dryland Needed

Facilities at South Dakota State University and its outlying substations for irrigation research, education and extension are being discussed rather extensively in South Dakota *Farm & Home Research* this year. One reason is that irrigation potential is coming more to the forefront and a sizeable segment of the state's agriculture has an interest in it. But that doesn't mean that South Dakota's cornucopia will be provided only by irrigated crops. Far from it. That horn of plenty will reach its potential only through both dryland and irrigation.

We're going to need a lot more know-how for either irrigation or dryland farming just to keep pace with other regions. Agricultural Experiment Station research is geared so that the most can be obtained from each dollar spent—for irrigation or dryland or, when possible, a combination of the two.

Eighty percent of those farmers taking part in the Yield Explorer event used fertilizers, 72% used chemical weed controls, all used recommended varieties while 44% used certified or registered seed, 57% of the small grain was treated with fungicide, and 70% was summer fallowed.

Factors Other than Moisture

Moisture was a big factor in most of those yields illustrated above. At many places in the state it was a good year, partly because rains came when needed. But also, those higher yields were obtained because plant food was available so the crops could make best use of it. And farmers used chemicals to stop weeds from doing the same.

While water is the most significant limiting resource in producing crops in South Dakota, research has been helping farmers to get the most

South Dakota State University

SERVING THE PEOPLE OF SOUTH DAKOTA THROUGH TEACHING, RESEARCH, EXTENSION

SOUTH DAKOTA FARM & HOME RESEARCH

Volume XIX — Spring 1968 — No. 2

A Report of Progress

Duane Acker, Dean, College of Agriculture and Biological Sciences, and Director, Agricultural Experiment Station

Frank J. Shideler, Editor. (Editorial Office, South Dakota State University, Brookings, S. Dak. 57006)

Published quarterly by the Agricultural Experiment Station, South Dakota State University, University Station, Brookings, South Dakota. This publication will be sent free to any resident of South Dakota in response to a written request.

To simplify terminology, trade names of products or equipment are sometimes used. No endorsement of specific products named is intended, nor is criticism implied of products not mentioned.

out of available moisture. Development of better, more suitable varieties, including those with drought resistance, is one way. Improved tillage methods are another in a long list.

Soil fertility is also a limiting factor statewide in crop production. Fertility can be made adequate by use of commercial fertilizers in addition to legumes and manure. However, South Dakota is low in fertilizer use per crop acre. One reason claimed for the limited fertilizer use has been low and variable rainfall. However, it is a well known fact that fertilized crops make the best use of the available moisture. This higher water use efficiency due to use of fertilizers in small grain has been demonstrated repeatedly through higher yields.

Weed Control AND Fertilizer

In corn demonstration plots, agronomists have shown that herbicide treatment for weed control alone increased yield enough to realize $5 for each dollar spent on herbicide. By adding nitrogen fertilizer to plots the herbicide returned over $12 per dollar invested. A farmer who lives on the fringe of the Corn Belt figured he netted $42 an acre on corn. He tried fertilizer on oats and netted $45.

Improving grasslands poses a real challenge to those involved in education and research as well as to farm and ranch operators who own and manage them. One reason grassland improvement and development has not progressed as much as for crops is that sale value, as well as real estate taxes, on grassland have increased faster than grassland productivity. This crop covers so much of South Dakota that irrigation will not have too great an effect—at least for many years.

While not as spectacular as some crops research, investigations have shown that ripping tight soils permits entrance of available water to greatly increase production on certain western grasslands. New species, fertilizer and management are other possibilities for grassland improvement. One SDSU agronomist says he is convinced that no other single pasture improvement practice offers such potential for increasing income as interseeding with legumes.

Corn Research

Narrow rows, adjusted plant populations, better use of fertilizers, weed control, are giving new insights into corn production. Even planting the corn so that it grows with all adjacent plants about the same distance apart ("equidistant planting" discussed elsewhere in this issue of *Farm & Home Research*) indicates possibilities for yield improvement.

"Rediscovery" of "old" crops may spark other dryland farming. For instance, barley production in South Dakota is only a tenth of what it was 25 years ago. One reason is lack of understanding of growth habits of barley. Another reason probably has to do with varieties. The new Primus barley grown on rundown soil of low fertility in Deuel county experiments last year with no fertilizer yielded 40.4 bushels an acre and gave a net cash return of $17.35. When optimum levels of fertilizer were applied, the yield was 99.3 bushels an acre with a net return of $50.50.

While you are going to hear a lot more about irrigation in South Dakota, don't give up on dryland farming. There is plenty of room—plenty of need!—for both in this state. □

CONTENTS

New Dairy Spread Details Released

Processing and ingredient details of the new low-fat dairy spread which Agricultural Experiment Station dairy scientists have been testing and improving for more than a dozen years were made available early in April to South Dakota dairy food processors.

The two dairy scientists who developed the product are Shirley W. Seas, assistant professor, and Kenneth R. Spurgeon, associate professor. They have authored Agricultural Experiment Station Bulletin 543, "New! Spread-Type Dairy Product," which tells all about the new spread including the formula, equipment used, consumer surveys, packaging, keeping quality, processing flow chart, and uses. Also provided are several recipes developed by the SDSU College of Home Economics.

Queries about the spread have been received from 24 states and seven foreign countries during the past few years, many of them as a result of research progress reports in news media (see also South Dakota *Farm & Home Research*, Vol. XVII, No. 3, Summer 1966). Interest has also been keen among dairymen looking for a new product that could move more dairy ingredients.

It is not known how much time processors will need to establish their manufacturing and marketing procedures. South Dakota dairy food processors were provided with all information about the product early in April. The bulletin describing the spread and its manufacture was made available May 1 from the Dairy Science Department or the Bulletin Room at South Dakota State University.

Scores of recipes using the new spread have been developed by the College of Home Economics. A publication containing many of these recipes for home use is expected to be available in the next few weeks. □

New South Dakota Crop

Certified Kentucky Bluegrass Seed

Kentucky bluegrass growing in a South Dakota field prior to harvesting. Certified seed is combined.

With **J. Duane Colburn,** associate professor, Agronomy Department, and manager, Seed Certification Service, Agricultural Experiment Station

ONE OF South Dakota's lesser-known crops grows "naturally" on millions of acres in the state but is one of the toughest in the book to produce because markets call for a near-perfect product.

The crop is Kentucky bluegrass seed, the lawn growers' standby for generations. But this is more than just Kentucky bluegrass seed, it is *certified* Kentucky bluegrass seed which definitely isn't mill run.

Main reason this crop is so hard to produce is that certification standards are purposely kept extremely high in South Dakota to provide a product that competes with the best and ranks among those at the top in the nation.

Main markets for the seed from South Dakota are in the eastern United States. Much of the seed is used for producing certified sod which is in great demand. The eastern market is currently supplied South Dakota certified Kentucky bluegrass seed by the South Dakota Kentucky Bluegrass Association of Huron.

Program Started in 1967

The Kentucky bluegrass certification program started in South Dakota in 1967, mainly because of the demand for certified seed in the East. A total of 8,451 acres were certified last year.

Incidentally, how come *Kentucky* bluegrass in South Dakota? No one seems to know. The plant originally came from Europe, it is believed, and was named for Kentucky in the early 1800's by settlers. Efforts to trace its history in South Dakota have been unsuccessful. Records indicate that early settlers found the grass growing in profusion. They called it Junegrass because it headed out in June. But bluegrass has volunteered where man has entered temperate climates and is known as one of the world's most successful plants.

In South Dakota the extreme environmental stresses and plant competition have forced a vigorous natural selection process in bluegrass that goes on all the time. The certified seed will produce a hardy, uniformly colored and even-growing turf with plenty of bred-in resistance to extremes in temperature and environmental conditions.

Certification Requirements Rigid

Fields of bluegrass to be certified must be at least 10 years old although many of them are more than 50 years old. During this time the grass has survived severe conditions including temperature range from 39 degrees below zero to 118 degrees above.

Some of the other rigid requirements include bluegrass curing yard and bluegrass seed processing plant inspection of both the uncleaned lots and final cleaned lots; careful processing by one of seven seed plants approved by the state Crop Improvement Association; and a laboratory inspection. The lab inspection has minimum standards requiring at least 95% pure seed, 85% germination, no noxious or objectionable weed seeds, 0.1% weed seed, 0.1% other native species and 5% inert material.

The freedom-from-other-seeds part of the standards certifies that the South Dakota product is free of a list of six fairly common cultivated grasses and 28 noxious and objectionable weeds including annual bluegrass. This annual bluegrass has been declared noxious by several states and is a troublesome weed in lawns and turfs. It has erratic habits including rapid growth in cool weather and quick disappearance in hot weather. Fortunately this annual bluegrass does not grow in the South Dakota plains area.

Actually, South Dakota certified Kentucky bluegrass seed has more than met the standards set for purity. One sample reported out of the lab at 99.50% pure, 0.50% inert, 95% germination, and completely free of other crop or weed seeds.

Excellent Test Weight

The South Dakota product also has excellent test weight, often superior to seed grown in other regions. The certified seed will weigh between 26 and 30 pounds per bushel. Heavy seed means plump seed which will give good seedling vigor, agronomists point out.

Cleaned seed lots are not tagged with the certification seal until they are completely processed. Representative samples are taken during the cleaning process of each lot. A one pint or 200-gram sample is required and no lot shall exceed 10,000 pounds.

The grower of certified seed must grow and market his crop according to definite rules and regulations so that the buyer will be protected against mixtures, noxious weeds, diseases and other factors that affect purity and quality. South Dakota State University with its special facilities and personnel has been assigned the testing and inspection duties for the Crop Improvement Association, a nonprofit, educational and public service organization.□

The official, final laboratory inspection of seed samples is done at the Seed Laboratory at SDSU. No single lot exceeds 10,000 pounds.

This is the way South Dakota certified Kentucky bluegrass seed goes out. Note the all-important tag at the top.

The dark blue South Dakota certification tag is the symbol of quality seed in South Dakota.

A certified Kentucky bluegrass field near Huron. (Left to right): J. Duane Colburn, SDSU agronomist who certifies the seed; Don Cook, Huron, grower and member of South Dakota Kentucky Bluegrass Association; and Raymond C. Kinch, SDSU agronomist who is field inspector.

Mist Irrigation

"Improving Climate"

By **Paul Prashar,** associate professor, Horticulture-Forestry Department

COVER—Mist was used to cool temperatures on hot days and to warm temperatures on cool early spring days in this experimental vegetable plot at South Dakota State University. This type of irrigation research may lead to practical applications which would give the South Dakota vegetable grower more time (plant earlier, harvest later) as well as better growing conditions during hot weather. It also may have application in other phases of commercial horticulture such as growing cut flowers and nursery stock production.

THE GROWING season of vegetables can be extended by proper use of water to cool or heat plants during adverse periods. Cool season crops can be planted earlier than the last frost-free date in an area by spraying a mist of water over them to raise the temperature. Similarly, a mist spray can be used to lower temperatures during hot periods to provide more favorable temperature for a crop.

If an effective method of controlling air temperature around plants can be found, the commercial vegetable grower may be able to produce better quality crops and more than one crop per season on the same land. This could help growers in South Dakota to increase their incomes.

Overhead mist irrigation can prevent plants from hard freezes. It also cools the plants and soil during hot weather by filtering out some direct sun rays and by absorbing heat. The increase in water vapor by mist results in an increase in solar energy

Details of the mist irrigation system may be seen better with the water turned off. The plot was 125x140 feet in size, the water lines 21 feet apart, and $6\frac{1}{2}$ feet high (to permit tractor cultivation), and spray nozzles were 7 feet apart on each line. Pipe size was $1\frac{1}{2}$ inches for main supply and $\frac{3}{4}$-inch for laterals with the nozzles. On a hot day the mist system may run several hours at a time. The nozzles were adjusted so that each nozzle put out one-eighth of an inch of water per hour with water pressure at 40 pounds.

for Cool Season Crops

adsorption by the atmosphere with a corresponding reduction in plant heating. As a result of this artificially produced microclimate there is a reduction in transpiration.

Cool Season Crop in July

An experiment at Brookings was designed to determine if mist cools air temperatures enough during July and August to produce a fall crop of cool season vegetables. On July 10, one month old plants of cabbage, cauliflower, purple cauliflower and broccoli were transplanted to field plots. A water pipe system was installed over the plot so that mist would cover the entire area. The water lines were 21 feet apart and mist nozzles were spaced 7 feet apart along the lines. An electric solenoid valve controlled by a thermostat was set to automatically turn on the mist system when air temperatures rose above 85 degrees (F.) and shut off the system when temperatures fell below 85 degrees.

Temperatures in the mist plots were from 1 to 14 degrees below the "outside" air temperature. Substantial reduction in temperature occurred when the outside temperture rose rapidly. If the outside temperature remained high for a prolonged period the difference between it and the temperature inside the mist plots was reduced by about 5 degrees.

Better Crop Under Mist

In this study positive correlation between the outside air temperature and the temperature in the mist plots indicates that the application of mist type of irrigation could be an important consideration in growing cool season crops in South Dakota during hot summer months. In this experiment, less total water was used by mist irrigation as compared with a sprinkler system to produce a cauliflower crop. Under mist irrigation 93% of the cauliflower heads were graded as U. S. No. 1 as compared with only 77% under the sprinkler system. With mist irrigation, it would be possible to apply, through the system itself, certain herbicides, insecticides, fungicides and additional fertilizer during the growing season.

Wind, soil, crop and other factors must be taken into account at each location where this type of irrigation is attempted. Low price crops, such as cabbage, are not economical to produce under mist irrigation. Crops such as cauliflower and broccoli should give better returns. □

These cabbages are at one edge of the plot. Note the smaller plants at the right. These were outside the effective area covered by the mist.

A Research Tool . . .

Light Measurement

By **Paul D. Evenson,** assistant professor, Agronomy Department

ENERGY IS the driving force which moves all matter in the universe. It occurs in six general forms: mechanical, heat, light, chemical, electrical and nuclear energy.

Sunlight is the main energy source on earth, and it is extremely important to agriculture. Sunlight is necessary for production of carbohydrates through the process of photosynthesis in plants. The heat resulting from sunlight striking the earth influences all chemical, physical, and biological processes in the plant and its enviroment. Scientists, by measuring and studying sunlight, extend their understanding of plant responses to environmental conditions.

One of the most useful light measurements for these scientific studies is net radiation. In general terms, net radiation is the total amount of light energy or radiation (from the sun) received at the earth's surface minus that which leaves the earth's surface. It is analogous to net income—that is, total income received minus expenses. And net radiation may be negative (during the night) just as net income may be negative.

Technically, net radiation is the difference between the incoming and outgoing solar and longwave thermal or thermal radiation as defined in meteorological terms. It is usually denoted by the following equation:

$$Rn = (\text{incoming } Rs + \text{incoming } Rt) - (\text{outgoing } Rs + \text{outgoing } Rt)$$

where Rn is the net radiation and Rs and Rt are the solar and thermal radiation.

Solar or shortwave radiation contains light in the 0.3 to 3 micron wavelength (1 micron is 1/254,000th of an inch). It is received at the earth directly from the sun and from sunlight diffused by clouds and water vapor.

Longwave Thermal Radiation

All objects which have temperature radiate longwave thermal radiation (wavelengths greater than 3 microns) at a rate related to the fourth power of their absolute temperature. The earth, water vapor, carbon dioxide, ozone, and water droplets (clouds) in the air all emit thermal radiation. The daytime radiation balance is illustrated in figure 1.

Net radiation is measured by placing a blackened plate (net radiometer) in a horizontal position and finding the difference in temperature in the two sides of the plate. A very sensitive temperature measuring device called a thermopile, which looks like a single strand of wire wound around the plate, is used to measure this temperature difference. Black surfaces change light to heat, and the difference in temperature is related to net radiation.

Net radiometers are constructed in either ventilated or shielded designs, but both instruments use the same basic principle of measurement discussed above. Air is blown equally across both sides of the plate in the ventilated type to overcome winds which might cause erroneous measurements. Polyethylene hemispheres are placed over the plate in the shielded type to avoid winds altogether. Both types of net radiometers are shown in figures 2 and 3.

Partitioning of Net Radiation

Net radiation at the earth's surface is transformed into various energy components. This partitioning of net radiation Rn is expressed in the following equation:

$$Rn = E + A + S + M$$

where E is the energy used to evaporate water from soil and plant surfaces (evapotranspiration), A is the energy used to heat the air, S is the energy used to heat the soil, and M is a miscellaneous term which includes such items as the energy used by plants. The last term is often omitted since it is usually small. The equation is termed the "energy

IS IT REALLY "PUSH BUTTON FARMING?"

You've probably heard the expression "push button farming."

Generally it is used in references to the way farming will be done in the future through automation, radio-TV, computers and an array of other even more sophisticated instruments.

But is "push button farming" the right term? "Easier farming" isn't exactly right either. Perhaps "precise farming" might come closer. Actually, scientists, through research, are looking for ways to take more of the risks out of farming. But "less risky farming" doesn't sound as fascinating as "push button farming" so the latter term will probably remain as the peg on which is hung a lot of important new research.

In the accompanying article the author describes work being done by Agricultural Experiment Station personnel to learn more about the effect of sunlight on growing crops.

In research at Centerville in southeastern South Dakota, for example, the author says about 40% of the variation in soybean yields caused by different cultural methods can be explained by net radiation values determined with light measuring devices. Some of the same type of work is also included in irrigation research at Redfield (see "Precise Information for Irrigation Planning," South Dakota Farm & Home Research, Vol. XIX, No. 1, Winter 1968).

When this research is applied under varying South Dakota conditions its use will improve the environment for crop production.

budget," and its primary use is to determine the amount of water (E) used by crops, although the other terms are of great interest to scientists studying plant responses to environmental conditions. The evapotranspiration term also is used to predict irrigation needs.

Figures 4, 5, 6 and 7 illustrate how crop canopies shade the soil when row spacings are changed. Net radiation measurements are used to evaluate the effectiveness of canopies and determine the factors responsible for yield increases from these various planting arrangements.

One such study involving soybeans was discussed in the seventh annual progress report of the Southeast South Dakota Experiment Farm near Centerville. Soybeans were grown in three population densities (75,000, 100,000, and 150,000 plants per acre) in each of three row spacings (20, 30, and 40 inches). Net radiation measurements were made with shielded net radiometers above the crop and between crop rows when the soybeans were near maximum growth. Measurements between the rows were made with net radiometers attached to sleds (figure 8) which were pulled between the rows to obtain an average measurement. Net radiation at the soil surface was expressed as a percent of the net radiation above the crop. The effectiveness of the crop to intercept radiant energy increases as the percent net radiation at the soil surface decreases. Net radiation received at the soil surface is used to heat the soil, to evaporate soil water (if present), and to heat the air above the soil.

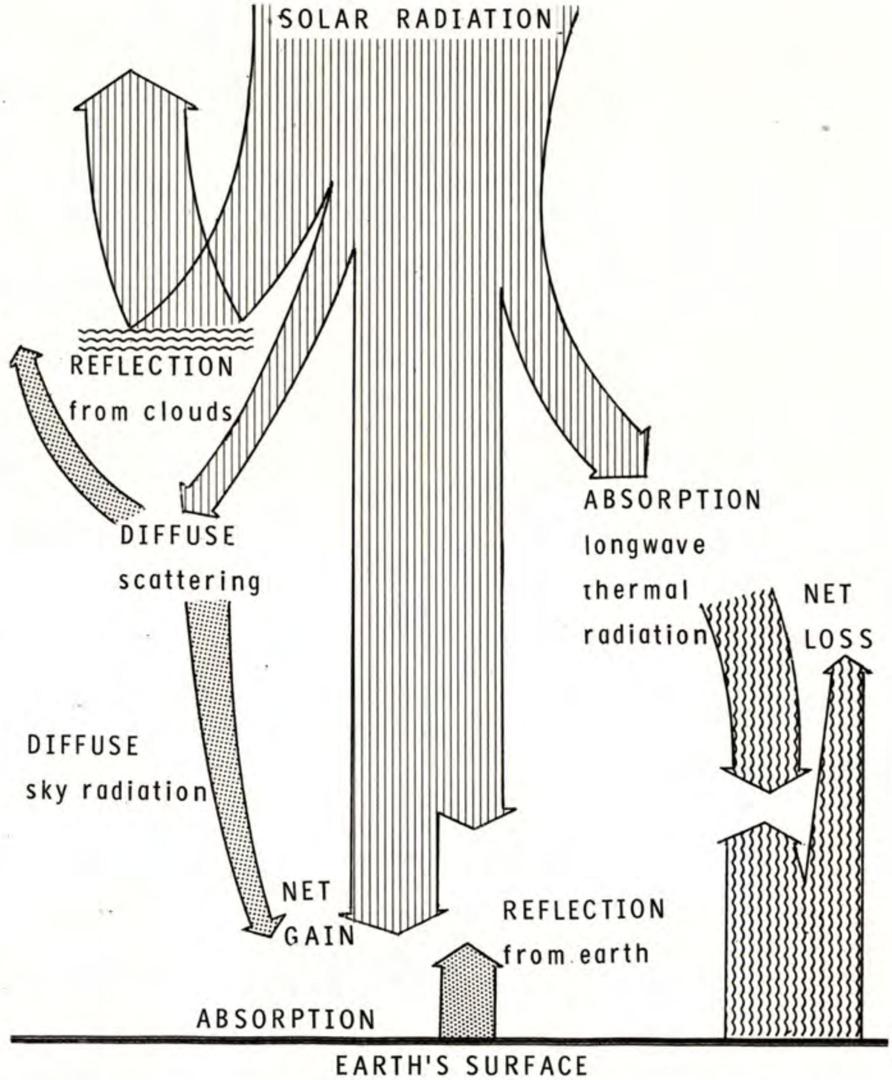


Figure 1. Daytime radiation balance showing sources of radiation.

Relationship to Row Spacing

The relationship between percent net radiation and row spacings at the various population levels becomes apparent in figure 9. In general, the percent net radiation that reached the soil decreased as row

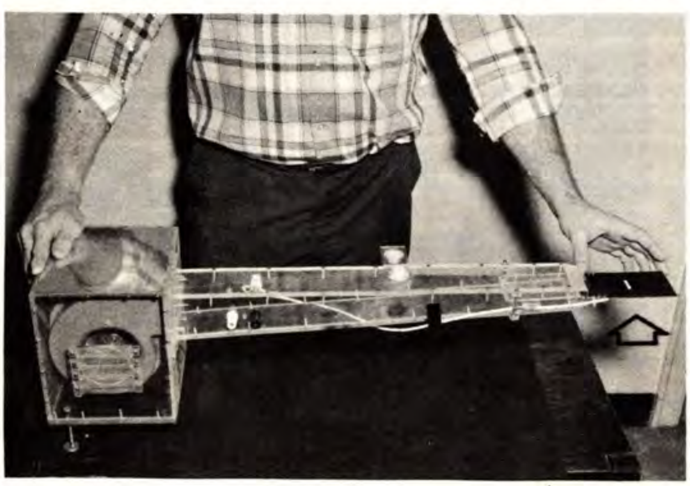


Figure 2. Ventilated net radiometer with blackened plate at right (arrow).

Figure 3. Miniature shielded net radiometer. Blackened plate is inside bulb-like shield.

Figure 4. View (with camera pointed straight up from soil surface) of leaf canopy formed by corn planted in 20-inch rows at 18,000 plants per acre. Considerable sunlight is blocked out by the leaves.

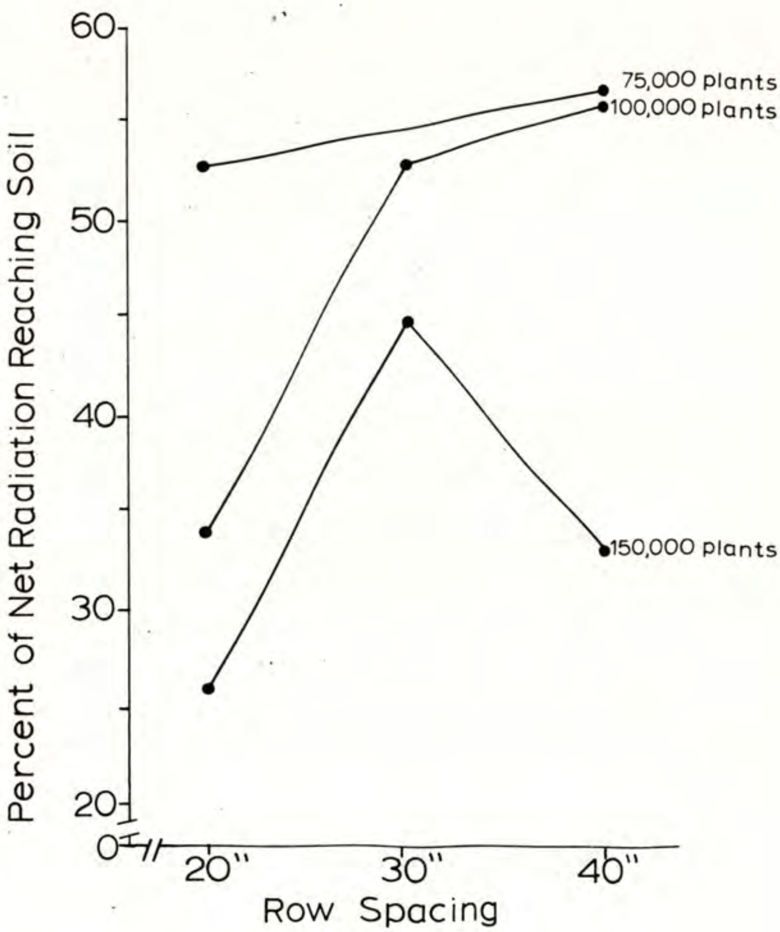
Figure 6. The leaf canopy of this 20-inch row sorghum shuts out most of the sunlight.

Figure 5. Similar view of corn planted in 40-inch rows at same population (18,000) shows more sunlight penetrating the canopy.

Figure 7. As rows are widened (here to 40 inches) more sunlight appears to penetrate the canopy.

Figure 8. Three shielded type net radiometers (also shown in figure 3) attached to a "sled" that was pulled between rows to obtain an average measurement. Attached wires carry electrical outputs to a recorder. Several widths of sleds are used to correspond with row widths.

Figure 9. Relationship between percent net radiation reaching soil and row spacings at various population levels.



spacings narrowed and populations increased. One exception is the 40-inch row spacing at 150,000 plants per acre. Soybean growth was particularly lush in this plot which accounted for the low value.

The relationship between soybean yields and net radiation values is shown in figure 10. About 40% of the variation in yield could be explained by this measurement. To explain more of this variation, all environmental factors, including net radiation, must be evaluated for each planting arrangement because these arrangements create different plant environments. The key to finding the best planting arrangement lies in finding the optimum environment for plant growth.

Use of net radiometers and other energy measuring instruments will be increased as research continues. They should be standard tools for scientists investigating crop and soil management practices and may aid investigators in other types of agricultural research. Such devices could be used to provide continuous records of the environment at all Agricultural Experiment Station research sites in the state. A network of these and other environmental measurements taken from all types of ground cover could be integrated with measurements and photos from orbiting satellites to aid short-term weather predictions and to evaluate statewide agricultural conditions such as crop conditions, soil temperature and soil moisture content.□

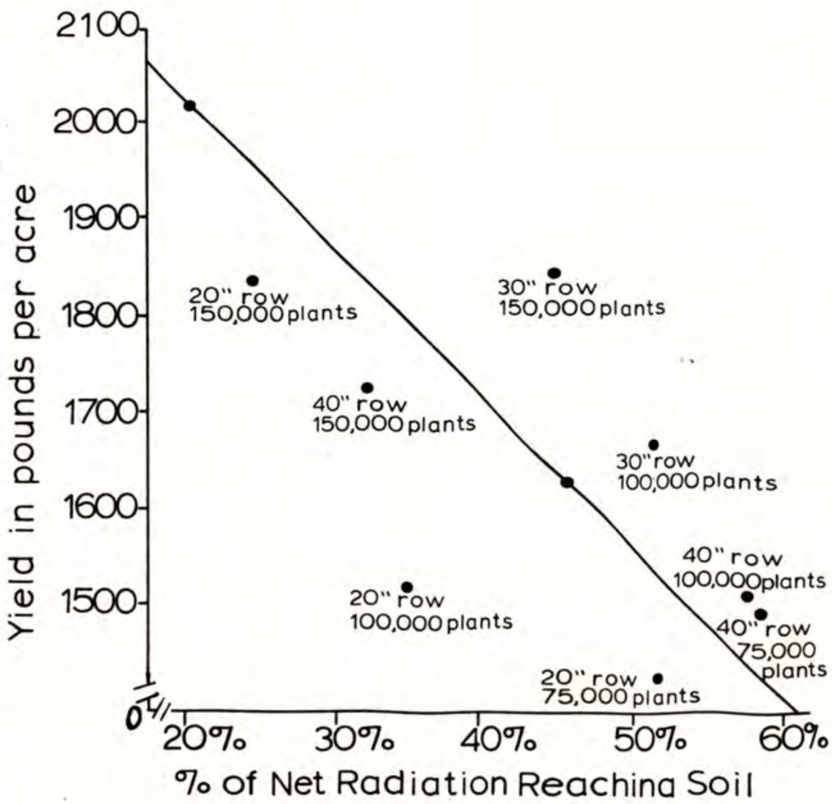


Figure 10. Relationship between yield of soybeans and percent net radiation reaching the soil.

First on the Range . . .

HORN and FACE FLY CONTROL

With Aerial Spraying

For ULV spraying, the aircraft operates at about 50 feet altitude (higher than for crop spraying), which reduces spooking of cattle.

AN UNPRECEDENTED air offensive in South Dakota this summer will find aerial sprayers flying missions against two costly range cattle enemies: horn and face flies.

Countless 50-foot-level strikes by this agricultural air force will bomb hundreds of thousands of cattle with an insecticide spray so fine it's almost invisible. The insecticide is harmless to cattle but deadly to horn and face flies. The past 2 years it has controlled fly populations over vast range areas as never before.

This air power version of a 1968-type range war is all the result of an Extension worker's idea – an idea that works so well he's had requests for information from 30 other states and three foreign countries. The cost is comparatively low at 25-35 cents per cow-calf unit. A major advantage is bringing almost instant fly control to the range without a costly, time consuming cattle roundup necessary when ground sprayers are used.

Pioneer in the technique for range cattle is Benjamin H. Kantack, entomologist with the Cooperative Extension Service at South Dakota State University.

Started Experiments in 1964

In 1964 while battling corn rootworm in southeastern South Dakota, Dr. Kantack tried ultra low volume (ULV) aerial sprays against this crop pest. During this work he talked—not incidentally—Aerial Sprayer Walter Ball of Huron into taking a few passes over a nearby cattle herd with his ULV-rigged plane. The Extension entomologist, also not incidentally, had a small supply of nearly pure malathion on hand for just such an experiment. Still not incidentally, he'd also taken a previous close look at the cattle to check horn and face fly infestation.

"It was heavy," he says.

Right after Ball had flown his experimental mission Dr. Kantack again checked the herd. It was virtually fly free.

That is how and where the South Dakota effort started. The next year with the help of Norbert Faulstich and the late Joe Sperl, Charles Mix county agents, ULV was demonstrated and tried on a wider scale with replicated herds on the Elvern Varilek and the Ed Krell ranches, both in Charles Mix County. Timing was checked during the summer to find out when to smack down fly populations before costly seasonal buildups.

Recommended First in 1967

By 1966 several aerial sprayers were pushing ULV and cooperating with Dr. Kantack and his co-worker. Dr. Wayne Berndt, Extension pesticide specialist. Additional re-

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This article on ultra low volume spraying of range cattle illustrates one way in which research results are made available to the persons who can use them.

Additional ULV research will be conducted this season by Edward U. Balsbaugh, jr., Agricultural Experiment Station entomologist who has assisted with some of the previous investigations.

The new research will involve several other ULV-type materials as well as cost factors, effectiveness, long and short residue periods, species of insects controlled and length of time controls are effective.

The experiments will be made in south-central South Dakota. Several commercial firms will cooperate.

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finements were made. In 1967 ULV spraying with malathion for the first time was included in Extension recommendations for controlling horn and face fly populations in South Dakota range herds. A combination of widespread news reports, satisfied ranchers and enthusiastic aerial sprayers soon spread the word around.

"Even the ranchers are now getting calls from distant points asking about effectiveness and cost factors of this ULV spraying," according to Dr. Kantack. "These ranchers are some of the best 'extension agents' you ever saw."

A well-known Spanish language farm magazine in Latin America will carry an article about the technique this summer.

"I can't get over how this 'stuff' takes flies," says Varilek, after using it on his purebred Angus.

"My neighbors and I had 900 head sprayed on five pastures and the job was finished in 4 hours," exclaims Gordon Petersen, Edmunds County rancher. "It would take five men 2 days to round up that many cattle."

"We used to ground spray," Petersen continues. "We had to build corrals. Then some cattle usually got out. And we always had to take the chance some animals would be injured."

Pleased With Results

Ernest Prebyl, a 500-cow rancher in Beadle County plans to try again this year. "Even with a late start last year we were pleased with the results."

"After spraying, our cattle would be grazing quietly while cattle in adjoining pastures would be bunched up fighting flies," Prebyl explains. "It doesn't take much of that to be worth a quarter a head," he adds.

Most of the insecticide falls on the back and sides of cattle—but flies are mobile and soon find the poison. Many ranchers say they have less eye trouble with their animals where aerial sprays give a high degree of face and horn fly control. Probably the reason for this is the better face fly control.

Bunched up and fighting flies, a herd pattern typical when horn and face flies are not controlled.

Within 4 hours after spraying with ULV malathion these cattle were fly free.

Dr. Kantack estimates that in 1967 more than 300,000 head of cows or cow-calf units were sprayed three to six times for control of horn and face fly as well as adult mosquito control.

"Financial benefits from properly timed, effective sprays can be tremendous," the entomologist calculates. "For example, USDA and other researchers estimate that during active fly season, cattle provided adequate horn fly control will gain half to three-quarters of a pound more daily than cattle trying to fight off high horn fly populations. This amounts to about 30 pounds more during a minimum 60-day active horn fly period or something like $7.80 per head under 1967 prices. Take out $1.00 a head average cost for four sprayings and you come up with a figure in excess of $2 million net profit on 300,000 head sprayed."

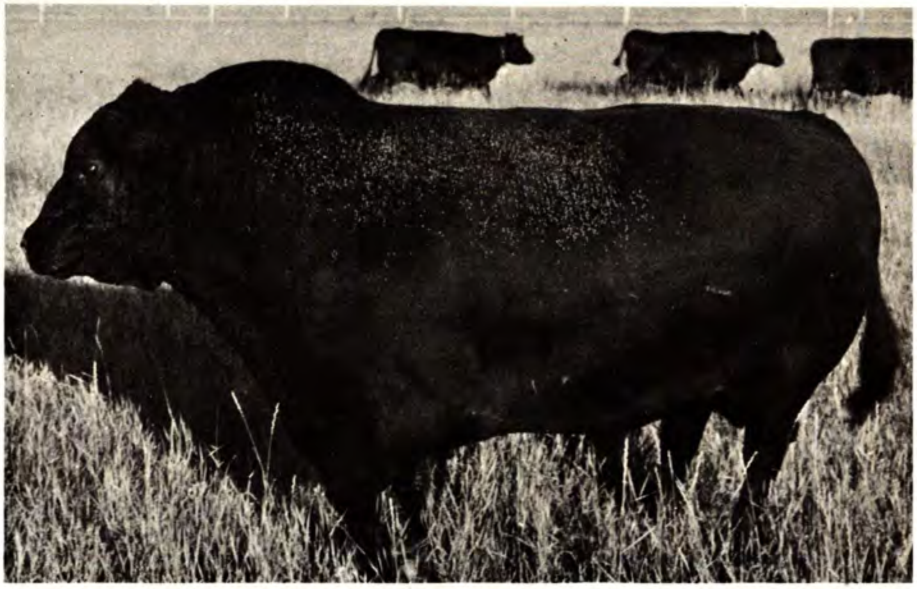
What ULV Means for Range

What does this ULV spraying mean in range county? Briefly here is a run-down:

- Only the herd and loafing area

Both cattle and flies like shaded loafing areas such as this one along a creek. ULV spraying rids the place of flies and provides an area where cattle loaf unmolested.

An estimated 10,000 horn flies covered this herd bull before ULV spraying. Within 30 minutes after spraying all were gone. Bulls' short tails can't reach to swat flies off shoulder so pilots make special efforts to spray these animals.



need to be sprayed—this limits the area involved and reduces cost.

- Treatments are needed about every 14-16 days during the fly season. Under South Dakota conditions four to six applications give season-long fly control.

- Spray initially when there are about 50 horn flies per side and/or five face flies per face. (How do you count flies on range cattle? Get a pair of binoculars, says Dr. Kantack).

- South Dakota doesn't recommend ULV malathion sprays for feedlot or farmstead fly control unless strict sanitation and residual sprays are also used. Stable flies and house flies are main feedlot-farmstead pests. Residual insecticides are needed for their control. The ULV malathion sprays gave excellent mosquito control over both range and farmsteads.

- Dairy cattle cannot be ULV sprayed—but their pastures can.

- ULV aerial spraying is not new, but doing it over range cattle is. The pure malathion is used at the rate of 8 ounces an acre.

- Flying at 50 feet (higher than for crop spraying) a 150-foot swath is sprayed in one pass, then overlapped 50 feet on the next pass. By using low-powered aircraft at this height there is less spooking of cattle.

- The insecticide is applied without water so evaporation is not a factor and the small amount of malathion goes a long way. It also means less weight. The plane can fly longer and farther.

Dr. Kantack explains that malathion is the only chemical so far cleared and recommended for ULV fly control spraying on cattle in South Dakota.□

Prior to another ULV demonstration mission over a herd in Charles Mix County, are (left to right): Bill Van Scoik, chemical company agronomist; Tom Varilek (standing), son of the herd owner; Benjamin Kantack, Extension entomologist; and Roy Crissman, pilot of Wagner.

How Old Is a Plant?

By **L. D. Kamstra,** professor, and **J. K. Lewis,**
associate professor, Animal Science Department

JUST AS A meat animal's age or maturity is of interest to the consumer, so is the age of plant to the range manager.

The age of plant affects the utilization of the forage by ruminants with the younger plant usually being the more palatable and easier to digest. The usual description of plant maturity, such as boot, flowering or seed stalk production, may not apply to plants which do not depend on seeds for reproduction. Western wheatgrass, a native prairie grass found in South Dakota, is one of many grasses that may not flower or produce seed during unfavorable conditions. The underground rhizomes of western wheatgrass will produce new shoots but their appearance has not been associated with maturity. Other clues to maturity become necessary to enable range managers to determine the age of the plant, and therefore, its value as an animal feed at any particular season.

Cutting Date and Maturity

Since the final measure of a plant's value for animal production is its production of total digestible nutrients,*in vitro* dry matter digestibility has been used as the standard measure of maturity in research at the South Dakota Agricultural Experiment Station. Later cutting date is usually associated with decreased digestibility. This is demonstrated when the digestibility of western wheatgrass plants collected at the Cottonwood Range Field Station at different cutting dates is compared—the plants became progressively less digestible from June 10 to September 12 (figure 1). In this comparison the topography, source, vigor class and leaf numbers were not varied. Cutting date appears to be a general measure of plant maturity if other factors are held constant, but this is not always possible.

Number of Leaves

As a western wheatgrass plant grows, more leaves are produced until growth stops.

To test the theory that a plant with more leaves at any particular cutting date is older, or at least less digestible, than a plant with a lesser number of leaves, collections of plants with various numbers of leaves were made at Pierre, Antelope Range Station and the Cottonwood Station at different collection dates. The comparison is shown in figure 2. Differences in digestibility could not be attributed to topographic location, range condition or number of leaves. The effect of cutting date, however, was again evident. Thus, leaf class (number of leaves per plant) can not be used as sole measure of plant age. This result was expected because lignin and other less digestible components may continue to increase after the development of new leaves has stopped. Thus, number of leaves per plant is useful as a measure of plant age and of digestibility only when the plant is actively growing.

Age of Plant Sections

Grazing animals may consume certain parts of plants which may differ in maturity from portions not consumed. For example, the top portions of grasses are consumed in preference to the less accessible lower portions. Western wheatgrass plants collected from Antelope Station in August were sectioned into top and bottom portions and the di-

Figure 1. Comparison of the in vitro cellulose digestibility of western wheatgrass at different cutting dates collected from the same location, vigor class and with one leaf class (5 leaves per plant). Plants became progressively less digestible from June to September.

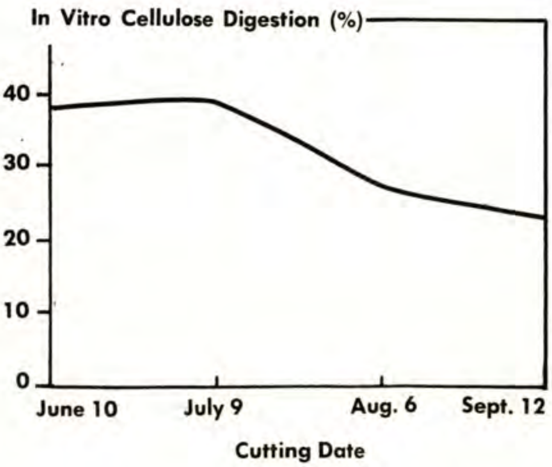
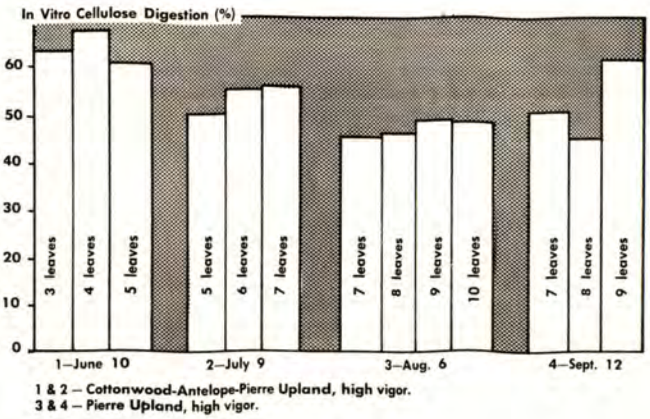


Figure 2. Comparison of the in vitro cellulose digestibility of western wheatgrass leaf classes collected by cutting date, topography and vigor class. Differences due to topographic position, range condition were not significant, but differences due to cutting date were significantly different.



gestibility compared. It was shown that animals which consumed the top portion would receive the most nutritious forage. The average digestibility of the top portion was 68.5% as compared to 50.5% for the bottom sections (figure 3).

In western wheatgrass, later emerging leaves are higher on the stem and are more succulent and should be more digestible. Samples for this study were collected from the Cottonwood Station on May 11, June 9 and July 14 and the leaves were removed from the stem and numbered from the bottom leaf. The comparison of leaf blades shown in figure 4 is more complex than the study of larger plant sections. If the digestibility of blades 2 and 3 from three-leaved plants cut May 11 were compared with the same blade positions on four-leaved plants from the same areas on June 9, blades from the May cutting were more digestible (67.8% vs 34.9%).

A further comparison of blades 2, 3 and 4 taken from four-leaved plants in July with similar blade positions from five-leaved plants at the same date, shows blades from the five-leaved plants were more digestible (55.5% vs. 45.9%). The picture is not clear cut since it can be observed that under heavy grazing the youngest leaves (top leaves) were most digestible, whereas in light grazing the youngest leaf was least digestible. This was not expected since younger tissue is usually more digestible than older tissue. However, at the time these samples were taken, a high percentage of the terminal shoots of western wheatgrass in the lightly grazed pastures were dead. The cause of death could not be determined.

Effect of Grazing Rate and Maturity

Although quite unexpected, grazing rate was shown to have a consistent effect on plant digestibility (figure 4). Western wheatgrass plants were collected from exclosures within heavily and lightly grazed pastures at the Cottonwood Station; that is, the plots were not grazed during the year the collections were made but had been grazed heavily or lightly from 1942 through the previous year.

At first it was difficult to imagine why the leaf blades removed from the same position on plants from heavily grazed pastures were much more digestible than those from lightly grazed pastures. When the

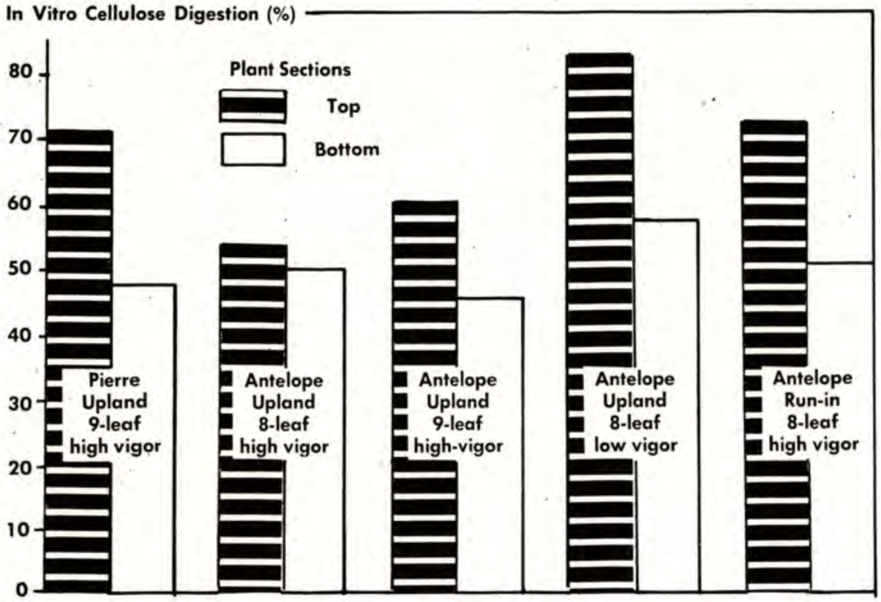
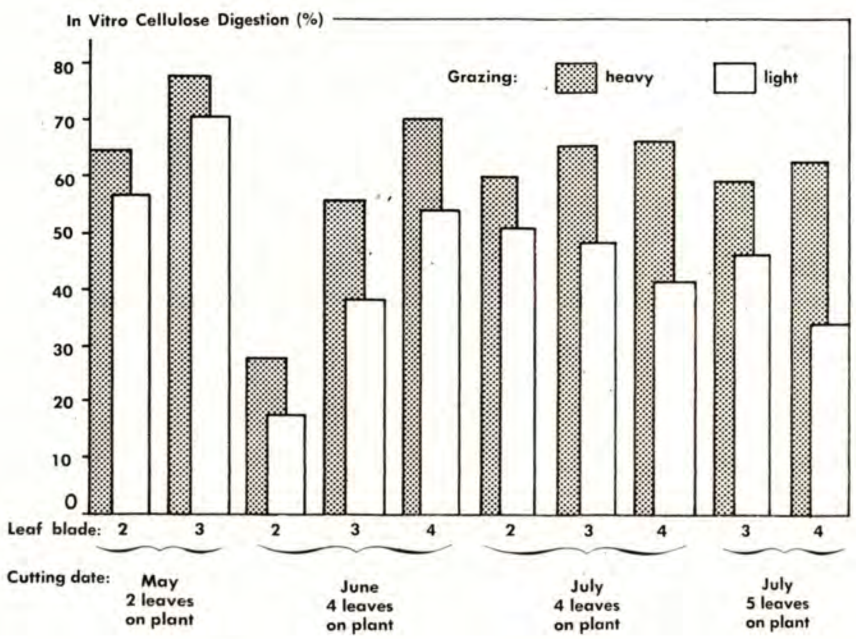


Figure 3. The digestibility of the top halves of plants cut from shallow clay uplands near Pierre in excellent range condition and from uplands and run-in locations at Antelope Range in August, 1962 were compared with the bottom half of the same plants. The tops were more digestible than the basal portion (68.5% vs. 50.5%).

Figure 4. Comparison of the in vitro cellulose digestibility of western wheatgrass leaf blades collected by leaf classes, cutting dates and grazing rates. Blades from heavily grazed pastures were more digestible than those from lightly grazed pastures. Plants in heavily grazed pastures emerged later in the spring and thus would be younger than lightly grazed plants if cut at the same date.



emergence date of plants from heavily and lightly grazed pastures was checked, it was found the plants from heavily grazed pastures emerged as much as a month later in some years and thus were chronologically younger plants. Likewise, plants from heavily grazed pastures were shorter. Thus, criteria other than cutting date are required for estimating the maturity of grasses that do not produce seed stalks.

The Chemistry of Maturity

The chemistry of maturity as used here is a comparison of carbohydrate lignin, protein and ash composition of plants collected at different cutting dates and with different numbers of leaves per plant.

Chemical components could be used as further proof of aging of plants since a plant which exhibits no outward signs of maturity may follow certain chemical patterns within. For example, an increase in a component called lignin is usually associated with poorer plant digestibility and maturation of plants. Agricultural Experiment Station studies found that lignin content approached a value equal to approximately half the cellulose content as the growing season progressed (figure 5). As both cellulose and lignin increased with later cutting date, the protein and ash (mineral) content decreased.

The yield of holocellulose, hemicellulose and cellulose increased in July. Other research has suggested that a higher holocellulose and cellulose yield can be expected during the flowering of plants. Western wheatgrass usually flowers during the third week of June if flowers are produced. Thus, there is some indication non-flowering western wheatgrass builds structural components in a similar manner to flowering plants.

Neutral Sugars of Hemicellulose

Xylose, arabinose, glucose, galactose and trace amounts of rhamnose were found as structural components of western wheatgrass hemicellulose at all cutting dates (figure 6). Number of leaves per plant did not appear to affect the type or amount of sugars found. Xylose was found to be the principal sugar at all collection dates with lesser amounts of arabinose, glucose and galactose. It was interesting to note that the changing levels of arabinose and glucose were inversely related; that is, when one increased the other decreased. It has been suggested that a decrease in glucose content is indicative of plant aging. It would also appear that increases in xylose and arabinose occur with western wheatgrass maturation.

It would appear that a complete picture of plant maturation cannot be obtained by any one criteria. Cutting date is a simple and valuable clue to plant age but as shown by the effects of grazing rates, plants taken under different growing conditions at the same cutting date will not necessarily be of similar maturity. □

Figure 5. Chemical components of western wheatgrass at different cutting dates. Factors associated with poorer animal utilization of forage (cellulose and lignin) increased whereas protein and ash decreased. Other components also showed seasonal change.

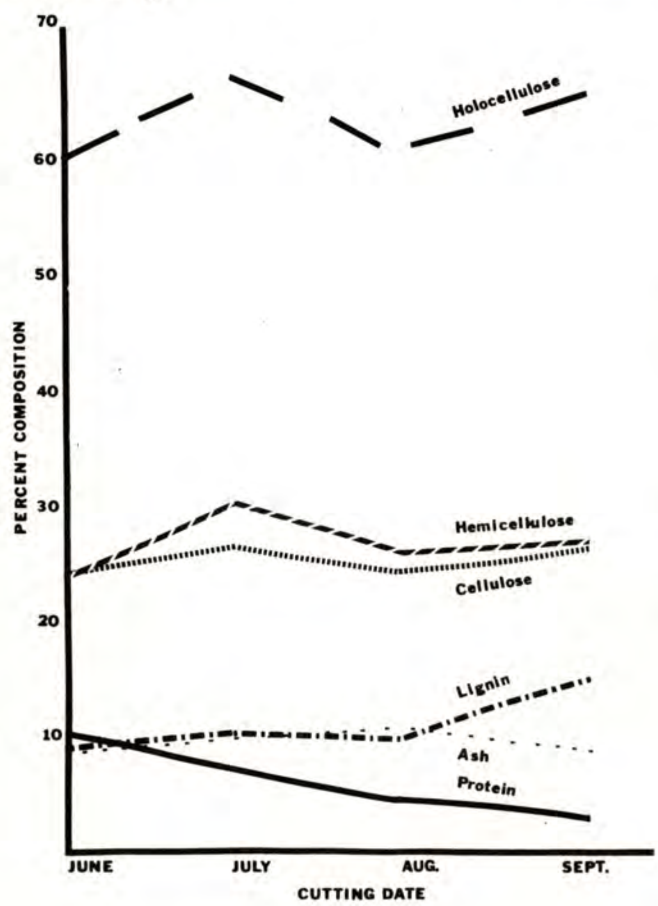
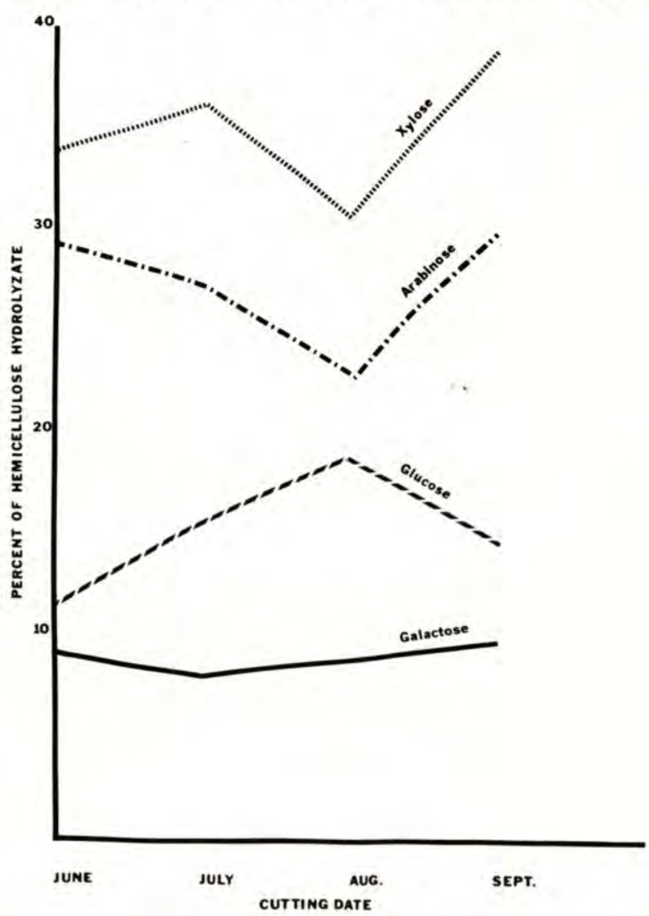


Figure 6. Neutral sugar components of western wheatgrass at different cutting dates. Changes in xylose and arabinose content of forage hemicellulose appeared to be reflected by changes in glucose, all sugars were present at all cutting dates.



IRRIGATION in South Dakota

By **Arthur J. Matson,** associate professor, Economics Department, with assistance of
Norman M. Fischer, graduate assistant

IRRIGATION is commanding increased attention in South Dakota.

The acres irrigated appear to be at an all time high, with the prospect of additional water supplies being developed.

Among causes of heightened interest in irrigation are the potentials arising from reservoir impoundments and the survey of ground water aquifers. New technology in irrigation equipment has favored the adoption of feasible irrigation. Yield gains due to irrigation have likely been increased because of the response from practices applied in combination, including fertilization and weed control.

Irrigation has not been as common a practice in South Dakota as in many other parts of the country having comparable water supplies. Neither has the production from irrigated land been large compared to non-irrigated land for general farm crops in the state. Consequently, it is not easy to estimate prospects for success of irrigation on the basis of experience.

The reasons farmers have begun irrigating are varied. Reducing chances of crop failure from drought damage and increasing yields consistently year after year, along with use of other improved practices, are two major incentives for irrigating. After the presence of adequate water supplies has been determined, reasons for hesitation to start irrigating or in discontinuing the practice often relate to uncertainties about the yield response, suitability of soils, or uncertainties about labor, management, and capital requirements. With better knowledge of yield response, more complete soil classification and collection of data by which requirements for irrigating can be standardized for reference by farmers, some of these uncertainties should be reduced.

Since 1955, the South Dakota water permit law has prescribed the manner of acquiring the right to the use of water. All water within the state was said in that legislation to be the property of the people of the state. Irrigation is one recognized beneficial use of water. The rights recorded by the Water Resources Commission are an indicator of the amount of water allocated to land on which irrigation rights have been established.

The U. S. Census of Agriculture reveals that in South Dakota the number of farms irrigating has risen steadily since 1944. South Dakota Crop and Livestock Reporting Service information shows irrigated yields to be consistently above yields on non-irrigated land in the same area.

Trends in irrigation in South Dakota may help individuals in considering a decision to adopt irrigation and also may serve as a basis for allocation of water resources to serve public purposes.

This work was financed in part by funds provided by the United States Department of the Interior through the South Dakota State University Water Resources Institute, as authorized under the Water Research Act of 1964, Public Law 88-379.

Much of the information was obtained through cooperation of the South Dakota Water Resources Commission, Pierre.

RIGHTS

Irrigation Rights from Records of the Water Resources Commission

The 1955 South Dakota water law assigned general supervision of waters of the state to the Water Resources Commission. This included the measurement, appropriation and distribution of water with powers of regulation and control over allotment of waters according to beneficial and prior use.

State water law defines terms and prescribes the procedures to be followed in pursuing the stated policy of South Dakota in the use of water. An attempt to describe the law is not necessary to indicate trends in water rights being established under that law. Certain terms, however, are important in order to estimate the extent and trend of irrigation development in South Dakota.

Anyone intending to acquire a water right is required to make ap-

Table 1. Irrigat

	B 1956
Annual permits granted	
Surface source	4,405.67
Ground source	2,722.90
Total	7,128.57
Cumulative permit rights	
Surface source	4,405.67
Ground source	2,722.90
Total	7,128.57
Annual water license and vested rights granted	
Surface source	
Water license	472.09
Vested rights	
Ground source	
Water license	
Vested rights	823.50
Total	
Water license	472.09
Vested rights	823.50
Cumulative water license and vested rights	
Surface source	
Water license	472.09
Vested rights	
Ground source	
Water license	
Vested rights	823.50
Total	
Water license	[illegible]9
Vested rights	823.50

plication to the Commission before commencing construction of irrigation works. Certain rights, as having previously applied water to beneficial use at the time legislation was passed, are recognized as "vested rights." The law specifies a procedure of inspection of the water works after completion and the issuance of a "license to appropriate water" by the Water Resources Commission. For purposes in this report *vested rights* are taken to indicate water rights recognized as in existence at the time the permit law went into effect in 1955. The *rights under license* pertain to acreage developed for irrigation, although additional acreage may be already developed and has had water applied prior to inspection and issuance of a license by the Commission. Nevertheless, the cumulative acres under license can be regarded as an indication of the minimum acreage developed for irrigation.

Permits granted annually by the Water Resources Commission until the end of 1967 are shown by surface and ground source in table 1. The cumulative total supplied by both sources was approximately 167,000 acres. The water licenses issued and vested rights filed are also shown annually and cumulatively for each year in table 1.

There are interpretations and assumptions to be made in quantifying information on water rights into a single table. Any right from a multiple source which included a ground water source is considered ground water in table 1 because it was assumed that the original surface source had proved to be an unreliable supply. Also, not every permit was subjected to the investigation required to assure that each tabulation would agree with all others. The summations of water permit information given here are unofficial; however, the basic data came from the records of the Water Resources Commission. The totals and sub-totals can be taken as a close approximation of when and where water has been allocated to the purpose of irrigation.

The total acreage under irrigation rights of all kinds is pictured by the top line in figure 1. The ground source is shown by the lower line, above which is added the acres allocated water from surface sources.

Figure 2 illustrates the trend in surface water allocation for irrigation by year. The extent of water licenses issued and vested rights filed appears in the lower lines. Ordinarily, vested rights are also given water licenses.

Ground water allocations by acres on a cumulative basis appear in figure 3, again with total permit rights and those which had received approval for water license and as vested rights by Commission action.

The information presented in these tables and graphs indicates a rise in acreage being placed under irrigation rights. The ground water allocations have been greater than from surface most years. The year 1966 was an exception. The interest

ion water rights by acres east of the Missouri River as approved annually, and in cumulative totals by calendar year through 1967. An unofficial tabulation from information furnished by the South Dakota Water Resources Commission

1956	1957	1958	1959	1960	1961	1962	1963	1964	1965	1966	1967
7,704.67	6,894.13	460.11	1,734.80	2,129.96	2,135.78	3,332.60	2,237.80	4,934.60	5,081.09	21,721.11	10,067.97
9,226.30	17,836.34	3,057.27	5,437.27	4,807.30	1,548.80	7,838.82	3,360.84	4,906.70	10,179.00	9,434.41	13,711.83
16,931.26	24,730.47	3,517.38	7,172.07	6,937.26	3,684.58	11,171.42	5,598.64	9,841.30	15,260.09	31,155.52	23,779.80
12,110.63	19,004.76	19,464.87	21,199.67	23,329.63	25,465.41	28,798.01	31,035.41	35,970.41	41,051.50	62,772.61	72,840.58
11,949.20	29,785.54	32,842.81	38,280.08	43,087.38	44,636.18	52,475.00	55,835.84	60,742.54	70,921.54	80,355.95	94,067.78
24,059.83	48,790.30	52,307.68	59,479.75	66,417.01	70,101.59	81,273.01	86,871.65	96,712.95	111,973.04	143,128.56	166,908.36
1,264.09	400.50	600.48	—	—	202.27	746.50	1,208.49	1,272.11	—	1,035.40	640.88
425.09	74.00	438.58	—	—	167.27	—	36.50	—	—	576.40	—
2,351.70	3,853.60	2,430.90	—	—	244.50	430.00	2,310.53	1,150.20	559.60	3,824.90	1,437.47
1,445.30	673.90	85.00	—	—	—	—	—	—	—	—	—
3,615.79	4,254.10	3,031.38	—	—	446.77	746.50	3,519.02	1,272.11	559.60	4,860.30	640.88
1,870.39	727.90	523.58	—	—	167.27	430.00	36.50	1,150.20	—	576.46	1,437.47
1,736.18	2,136.68	2,737.16	2,737.16	2,737.16	2,939.43	3,685.93	4,894.42	6,166.53	6,166.93	7,201.93	7,842.71
425.09	499.09	937.67	937.67	937.67	1,104.94	1,104.94	1,141.44	1,141.44	1,141.44	1,717.84	1,717.84
2,351.70	6,205.30	8,636.20	8,636.20	8,636.20	8,880.70	9,310.70	11,621.23	12,771.43	13,331.03	17,155.93	18,593.40
2,268.80	2,922.70	3,007.70	3,007.70	3,007.70	3,007.70	3,007.70	3,007.70	3,007.70	3,007.70	3,007.70	3,007.70
4,[illegible].88	8,341.98	11,373.36	11,373.36	11,373.36	11,820.13	12,996.63	16,515.65	18,937.96	19,497.56	24,357.86	26,336.11
2,693.89	3,421.79	3,945.37	3,945.37	3,945.37	4,112.64	4,112.64	4,149.14	4,149.14	4,149.14	4,725.54	4,725.54

in irrigating from Missouri River reservoirs accounts for much of the increase in permits to irrigate from surface sources.

An unofficial estimate of number of permits and of acres for counties in eastern South Dakota is given in table 2. The counties are grouped for the purpose of this report only. Because records of water rights west of the Missouri River are more complicated and are not represented as well by the permits recorded since 1955, they will be reviewed and presented in a later report.

Figure 4 divides the state according to arbitrary county groupings, which roughly recognize boundaries of major tributary basins and political subdivisions of state government, as counties and conservancy sub-districts. The future distribution of rights will be influenced by such things as the presence of water supplies, progress in authorization and construction of federal projects (such as the Oahe project). and developments in technology which may cause irrigation potential to become feasible and acceptable for persons considering it. A larger issue is the place of irrigation among all uses of water, not only for this state, but for others with whom South Dakota shares a common water supply.

TRENDS

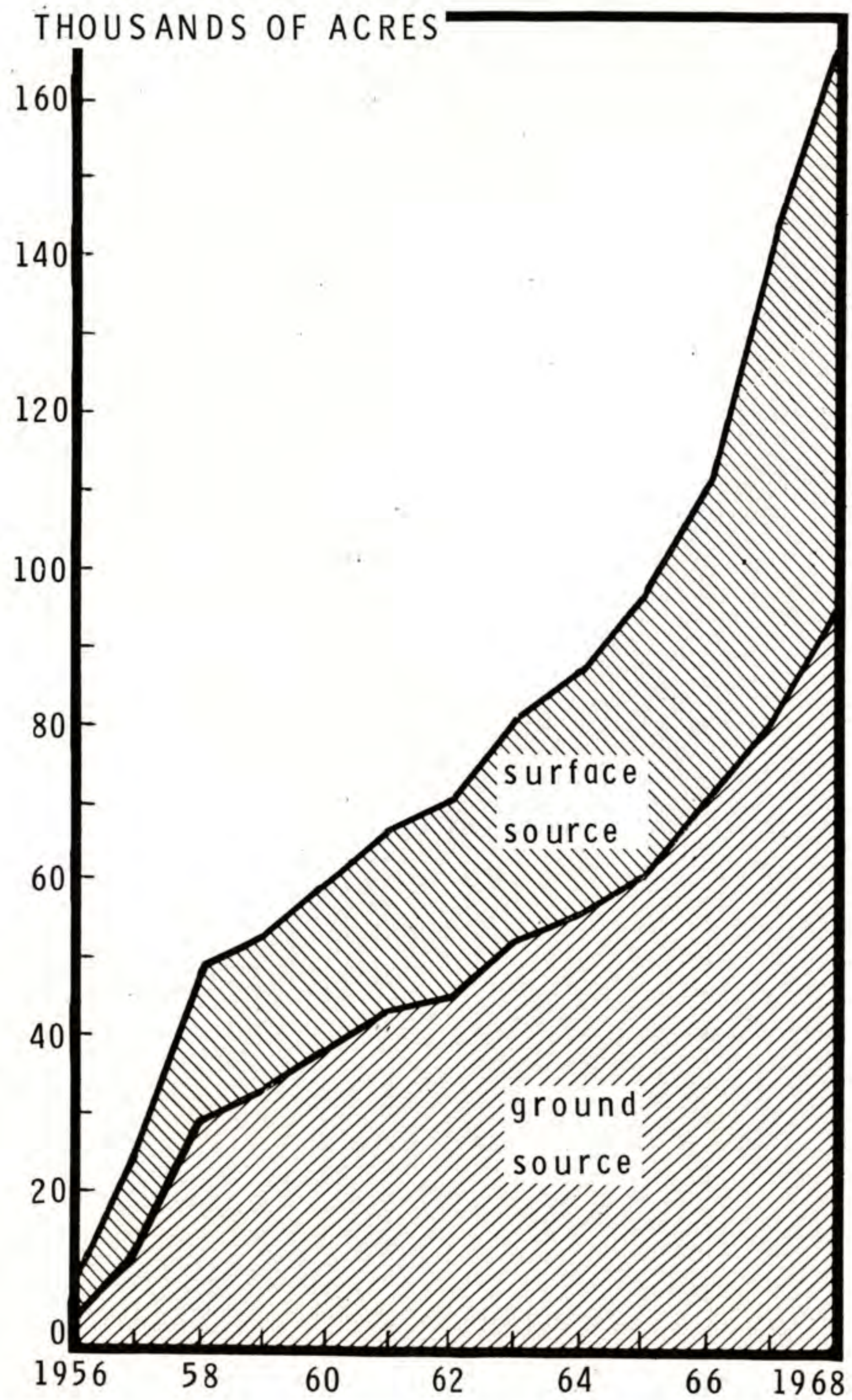
Extent of Irrigation from Census Information

Fluctuations in the numbers of farms irrigating and the acreage irrigated have occurred throughout the history of the state. Table 3 presents U. S. Census data as to the extent of irrigation in the state and the average number of acres irrigated ner farm and included in the whole farm. The number of irrigated farms and acres being irrigated during census years likely varies from the numbers between census years. However, general trends in adoption of irrigation practices are revealed by census records.

In 1964, a total of 1,005 farms irrigated 130,050 acres. The statewide average of nearly 130 acres irrigated per farm was the most on record. The average total size of irrigated farms was 2,166 acres, which as an average for South Dakota is not necessarily representative of many farms. A further breakdown among counties and regions of the state is given later in this report.

The line in figure 5 traces the fluctuations in irrigated farms in South Dakota from census data. Figure 6 leads to an observation

Figure 1. Acreage under irrigation right east of Missouri River in South Dakota by surface source and ground source as of January 1 following the calendar year during which action was taken by the Water Resources Commission, 1956-1968.



that acres irrigated have risen since 1944 and probably is at an all time high.

Table 4 is similar to table 3, but gives the extent of irrigation in percentages. With the decline in the number of all farms, the farms irrigating in 1964 rose to 2.02% of all farms, higher than any previous year. Less than three acres of a thousand were irrigated in 1964, but the 0.285% of all land in farms stood at a 20-year high. Six percent of land in irrigated farms was irrigated in 1964. The size of the irrigated farms, in total acres, has tended to be considerably larger than most farms, an indication that irrigation has been one practice, along with others, requiring large amounts of capital.

Variation in farms irrigating and land irrigated has occurred by region and census year. The counties of the state are grouped in table 5 by areas of the state with numbers of irrigated farms and land irrigated by census year shown.

A map of South Dakota with area subtotals from table 5 is included as figure 7. Readily noticeable are increases in the extent of irrigation as water supplies have been developed, as from Missouri reservoirs,

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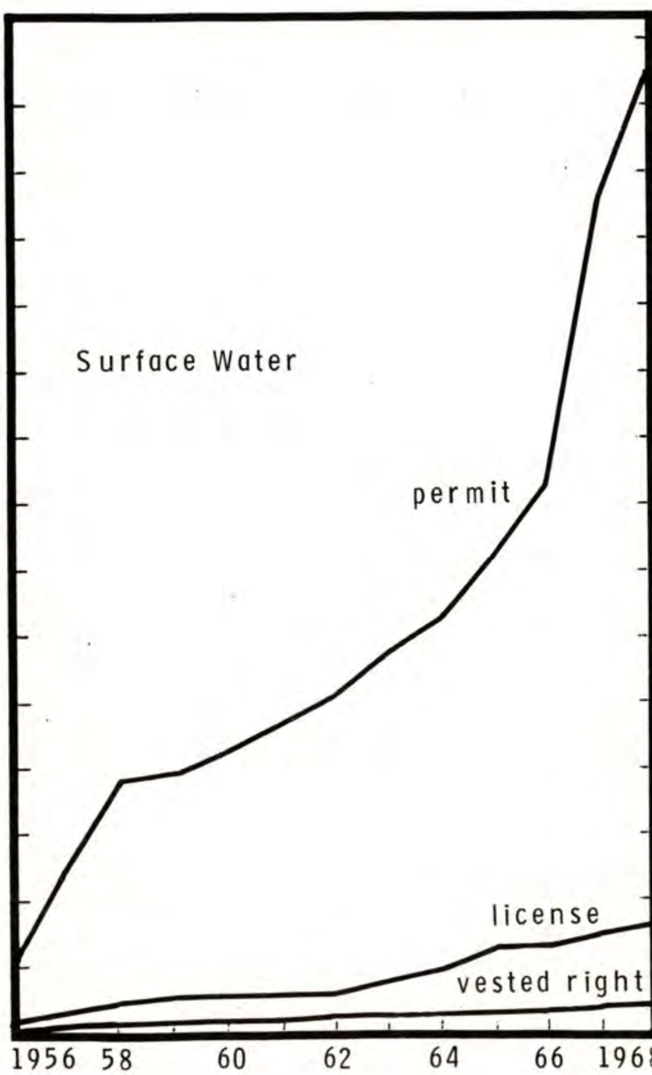


Figure 2. Surface water as source for acres under irrigation right by all types including appropriation permit, water license, and vested right as of January 1 following calendar year during which right was approved by the Water Resources Commission, 1956-1968.

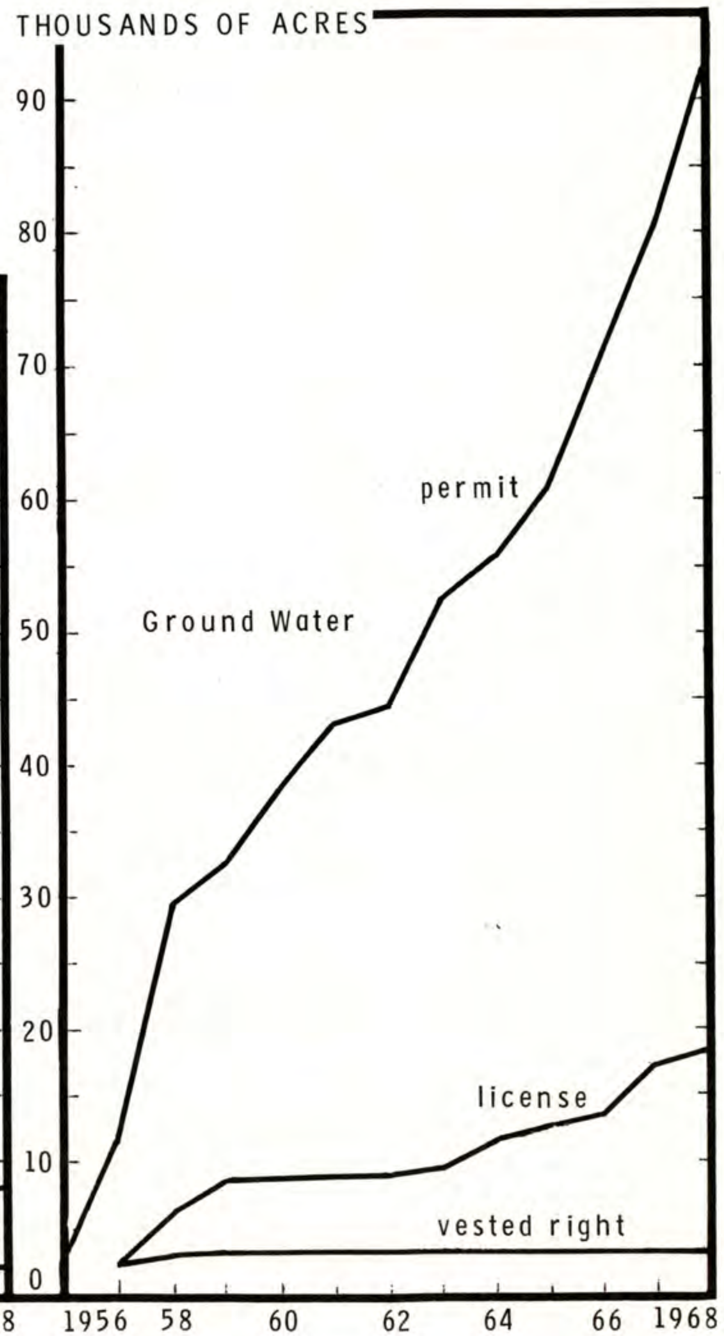


Figure 3. Ground water as source for acres under irrigation right by all types including appropriation permit, water license, and vested right as of January 1 following calendar year during which right had been approved by the Water Resources Commission, 1956-1968.

and as potentially adequate aquifers have been surveyed, as the Missouri lowland areas of Yankton, Clay, and Union counties.

YIELDS

YIELDS, ACREAGES COMPARED

The South Dakota Crop and Livestock Reporting Service cites acreages and yields for irrigated crops of alfalfa hay and corn for grain. Tabulation of data from those annual reports appears in table 6. The 10-year averages of acreage and yields for irrigated and non-irrigated corn and alfalfa from 1956 to 1965 are listed.

Although there is a difference in the yields of irrigated and dryland

(continued on page 24)

Table 2. Irrigation rights, by number and acres under permit for 44 counties east of the Missouri River as of January 1, 1968. An unofficial tabulation of information from the South Dakota Water Resources Commission.

	SURFACE		GROUND	
	Permits	Acres	Permits	Acres
North Central				
Campbell	6	1,404.91	1	130.00
Edmunds				
Faulk	1	36.50	8	
Hand	10	2,489.80	8	1,074.30
Hughes	29	7,084.38	8	1,443.90
Hyde	3	3,745.86	3	154.50
McPherson	4	209.50	1	480.00
Potter	3	607.10	1	195.00
Sully	4	6,002.00	9	4,436.00
Walworth	3	621.90	3	300.30
Subtotal	63	22,201.95	42	8,214.00
Northeast Central				
Beadle	27	5,241.60	55	11,398.80
Brown	3	326.00	4	1,024.17
Clark	1	160.00	7	1,724.07
Day			2	420.20
Marshall				
Spink	17	3,024.99	54	12,126.20
Subtotal	48	8,752.59	122	26,693.44
Southeast Central				
Aurora				
Bon Homme	7	1,210.00	2	205.10
Brule	4	304.90	3	685.00
Buffalo	7	7,658.60	1	1,165.00
Charles Mix	24	6,401.00	16	2,989.00
Davison	15	3,110.23	12	2,734.07
Douglas			1	156.90
Hanson	7	691.13		
Hutchinson	9	1,945.63	10	2,992.00
Jerauld	2	479.91	4	930.00
McCook			1	140.00
Miner	1	422.40	12	2,551.60
Sanborn	11	4,964.80	11	3,064.70
Turner	2	383.00	76	12,196.90
Subtotal	89	27,571.60	149	29,810.27
Eastern				
Brookings	5	291.51	19	2,883.80
Codington	5	727.00	14	2,194.50
Deuel			3	783.90
Grant	2	232.99		
Hamlin			7	1,019.80
Kingsbury			3	784.75
Lake	1	54.90	4	930.00
Lincoln	2	402.00	3	370.00
Minnehaha	23	3,039.13	14	2,114.55
Moody	11	1,726.47	7	866.19
Roberts	1	37.40	1	289.00
Subtotal	50	6,511.40	75	12,236.49
Southeastern				
Clay	3	1,186.27	25	4,685.70
Union	15	1,967.69	54	9,555.20
Yankton	19	2,469.80	26	3,270.60
Subtotal	37	5,623.76	105	17,511.50

Table 3. Irrigated farms, irrigated acres and average acres irrigated per irrigated farm and average total acres per irrigated farm in South Dakota 1889 to 1964 by census year. (NA: data not available.) Source: U. S. Census reports

Census Year	Number of irrigated farms	Total acres irrigated	Acreage per irrigated farm: Acres irrigated	Acreage per irrigated farm: Total acres in farm
1964	1,005	130,050	130	2,166
1959	1,002	115,629	115	2,240
1954	923	90,371	98	2,006
1949	807	78,069	97	1,457
1944	708	52,895	75	NA
1939	967	54,073	56	1,057
1934	974	56,565	58	NA
1929	763	59,361	78	497
1919	1,198	100,682	84	NA
1909	500	63,248	126	NA
1899	606	43,676	72	NA
1889	189	15,717	83	NA

Table 4. Number of irrigated farms as percent of all farms, land irrigated as percent of land in all farms and as percent of land in irrigated farms, and average size of irrigated farm as percent of average size of all farms in South Dakota by census year, 1889 to 1964. (NA: Data not available. Source: U. S. Census reports).

Census Year	Irrig. farms as % all farms	Land irrig. as % land in all farms	Land irrig. as % land in irrig. farms	Ave. size irrig. farm as % of aver. size all farms
1964	2.02	.285	6.00	263
1959	1.80	.258	5.13	278
1954	1.48	.201	4.88	279
1949	1.21	.174	6.66	261
1944	1.03	.123	NA	NA
1939	1.03	.137	5.30	194
1934	1.17	.152	NA	NA
1929	0.92	.163	15.69	113
1919	1.61	.291	NA	NA
1909	0.64	.243	NA	NA
1899	1.15	.229	NA	NA
1889	0.38	.138	NA	NA

	Number of Irrigated Farms			Land Irrigated in Census Year		
	1954	1959	1964	1954	1959	1964
Western Black Hills						
Butte	413	391	370	50,856	52,793	57,348
Custer	24	39	33	2,510	4,930	5,286
Fall River	94	94	91	8,965	11,420	11,598
Lawrence	75	52	50	3,316	3,530	4,184
Meade	39	41	45	3,974	3,400	4,790
Pennington	84	79	60	7,155	8,714	7,929
Subtotal	729	696	649	76,776	84,787	91,135
Acres/farm				105	122	140
Northwestern, West Central						
Corson	—	1	5	—	18	359
Dewey	1	—	—	10	—	—
Haakon	5	—	8	835	—	1,958
Harding	16	26	33	1,033	3,841	5,005
Perkins	13	13	12	1,086	987	991
Stanley	1	2	4	80	580	818
Ziebach	4	1	5	445	80	443
Subtotal	40	43	67	3,489	5,506	9,574
Acres/farm				87	128	143
Southwest Central						
Bennett	6	3	3	873	295	130
Gregory	—	1	4	—	275	555
Jackson	8	9	3	461	817	287
Jones	2	2	3	41	321	470
Lyman	1	2	5	415	162	245
Mellette	1	2	5	5	155	496
Shannon	13	5	4	1,022	726	589
Todd	6	5	—	920	408	—
Tripp	6	4	8	210	259	288
Washabaugh	6	1	2	419	395	510
Subtotal	49	34	37	4,366	3,713	3,570
Acres/farm				89	109	96
North Central						
Campbell	—	—	—	—	—	—
Edmunds	—	1	1	—	20	1
Faulk	2	—	2	115	—	40
Hand	2	2	5	165	245	1,008
Hughes	1	5	6	40	213	610
Hyde	1	2	2	40	124	145
McPherson	—	—	—	—	—	—
Potter	1	—	1	65	—	100
Sully	—	—	1	—	—	130
Walworth	3	3	2	130	59	61
Subtotal	10	13	20	555	661	2,095
Acres/farm				56	51	105
Northeast Central						
Beadle	7	19	22	469	3,395	3,522
Brown	7	2	2	147	4	8
Clark	2	1	5	666	40	804
Day	1	—	2	265	—	180
Marshall	1	—	—	40	—	—
Spink	15	18	27	1,377	2,392	3,516
Subtotal	33	40	58	2,964	5,831	8,030
Acres/farm				90	146	138
Southeast Central						
Aurora	—	—	—	—	—	—
Bon Homme	3	9	4	177	545	345
Brule	—	2	—	—	11	—
Buffalo	2	2	—	45	290	—
Charles Mix	—	13	16	—	1,974	1,890
Davison	5	5	5	49	266	581
Douglas	2	2	2	62	260	38
Hanson	3	2	1	5	62	82
Hutchinson	1	5	3	35	220	48
Jerauld	—	1	2	—	35	83
McCook	1	—	—	125	—	—
Miner	2	—	1	156	—	125
Sanborn	—	3	3	—	180	225
Turner	3	36	24	164	4,373	2,979
Subtotal	22	80	61	818	8,216	6,396
Acres/farm				37	103	105
Eastern						
Brookings	6	10	8	201	568	986
Codington	1	2	3	32	30	120
Deuel	—	—	1	—	—	25
Grant	1	1	1	75	100	15
Hamlin	1	—	3	70	—	255
Kingsbury	3	4	1	152	129	54
Lake	2	2	1	3	181	163
Lincoln	1	4	2	105	354	130
Minnehaha	7	14	7	162	1,235	721
Moody	3	4	5	124	405	407
Roberts	2	3	4	46	121	277
Subtotal	27	44	36	970	3,123	3,153
Acres/farm				36	71	88
Southeastern						
Clay	—	12	17	—	1,124	1,486
Union	10	25	43	380	1,826	3,226
Yankton	3	15	17	53	842	1,385
Subtotal	13	52	77	433	3,792	6,097
Acres/farm				33	73	79
South Dakota						
Total	**923**	**1,002**	**1,005**	**90,371**	**115,629**	**130,050**
Acres/farm				98	115	129

Table 5. Irrigated farms, and land irrigated in census years 1954, 1959, and 1964 by county in South Dakota. (Source: U. S. Census of Agriculture, 1954, 1959, 1964.)

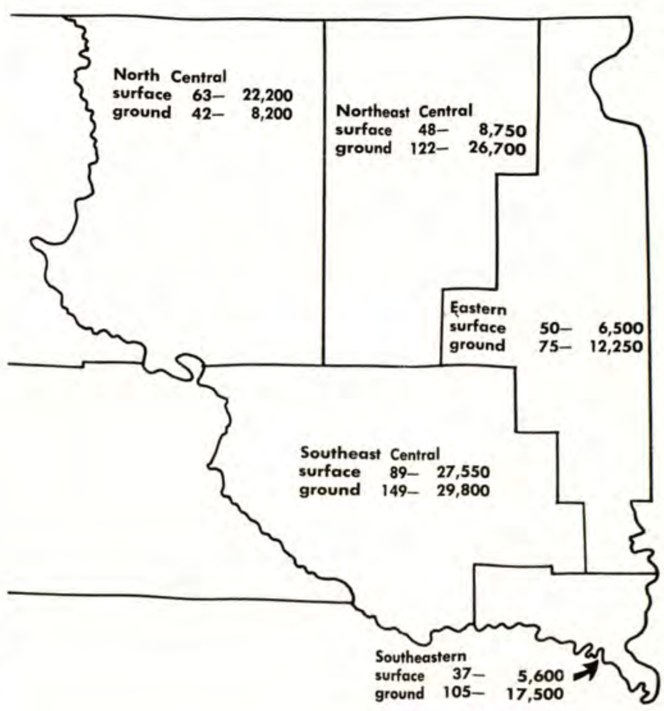


Figure 4. Permits for irrigation by number (left column) and approximate acreage (right column) in 44 counties east of the Missouri River in effect January 1, 1968, from an unofficial tabulation of information from the Souh Dakota Water Resources Commision.

(non-irrigated) harvested acres, caution is suggested not to assume that the difference is solely due to irrigation, or that the response from irrigation would be any more or less than the historic difference in yields. Figures for the state include widely distant locations and varying soils. A clear estimate of the response would require a region to be specified and relevant soil factors and other conditions well understood.

During the 10 years, 1.10% of corn production came from irrigated acres comprising 0.55% of all corn acres. The yield on irrigated land averaged 65.2 bushels of corn per acre, twice the yield on land not irrigated. Relationships are shown similarly for alfalfa hay.

The 10-year averages for irrigated and non-irrigated yields of corn are given in figure 8. The yields for alfalfa hay are shown in figure 9.

Ten-year average yields and acreages appear by county groupings in figure 10. Irrigated corn is mainly in the eastern part of the state, so that differences in yields for corn traced in figure 8 are rather regular. Alfalfa irrigation is concentrated in the Black Hills region, whereas other sections of the state have large acreages of dryland alfalfa. Perhaps for other reasons, too, the yields shown in figure 9 do not closely represent a comparison between irrigated and non-irrigated yields of alfalfa. A realistic response estimate must consider land features of slope, drainage, and texture and also climate and management factors. Irrigation, by and large, has not been prevalent and consistent enough to draw conclusions regarding yield response even on a regional basis from published yield data. A farmer would need to examine closely his own circumstances in deciding if he should begin irrigating.

Table 6. Acres irrigated for corn grain and alfalfa hay with difference in irrigated yields and dryland yields and percentage irrigated of all corn and all alfalfa hay in South Dakota from 1956 to 1965 inclusive. (Source: South Dakota Crop and Livestock Reporting Service reports).

	Ten Year Average 1956 to 1965
Irrigated land harvested	113,281 acres
Corn for grain	17,993
Alfalfa hay	48,465
Other crops	46,823
Dryland crops harvested	
Corn for grain	3,247,107 acres
Alfalfa hay	2,117,635
Yield per acre	
Corn for grain	
Irrigated	65.2 bushels
Dryland	32.4
Difference	32.8
Alfalfa hay	
Irrigated	2.44 tons
Dryland	1.39
Difference	1.05
Irrigated as part of total production and cropland	
Corn for grain	
Production	1.10%
Acres	.55
Alfalfa hay	
Production	3.84
Acres	2.24

The procedures necessary to follow in obtaining a water use permit are prescribed by state law and administered by the Water Resources Commission. Assistance in supplying the information required by the application for an irrigation permit can be obtained from personnel representing agencies of the federal and state government, qualified licensed engineers, and South Dakota State University specialists.

Figure 5. Irrigated farms in South Dakota by census year, 1889-1964.

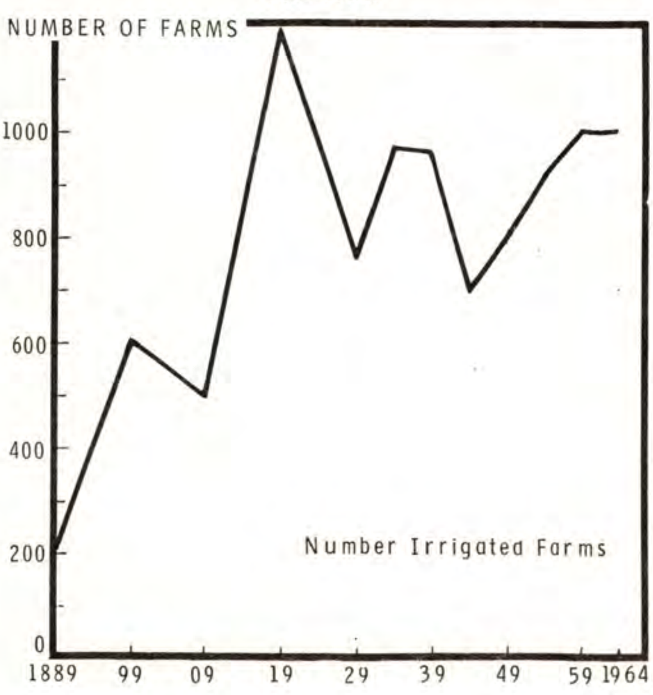
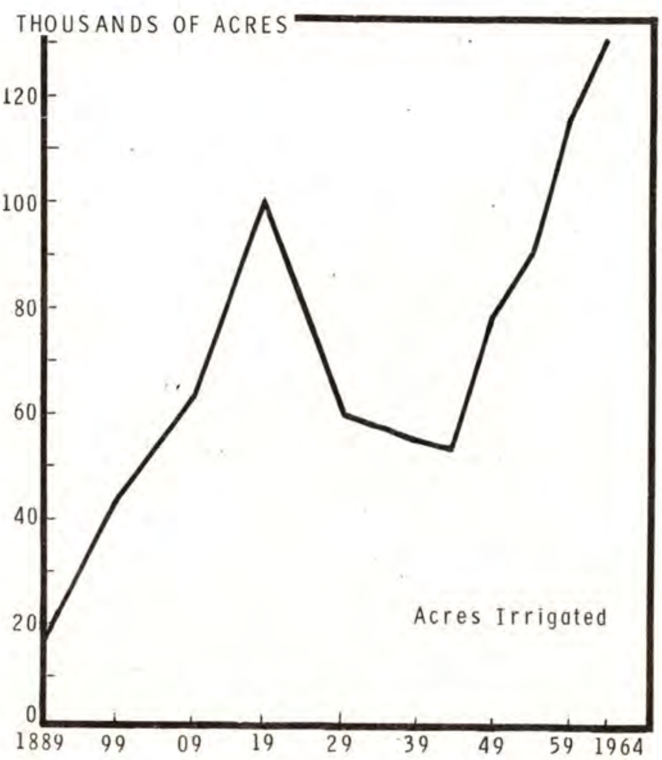


Figure 6. Total acres irrigated in census year in South Dakota, 1889-1964.



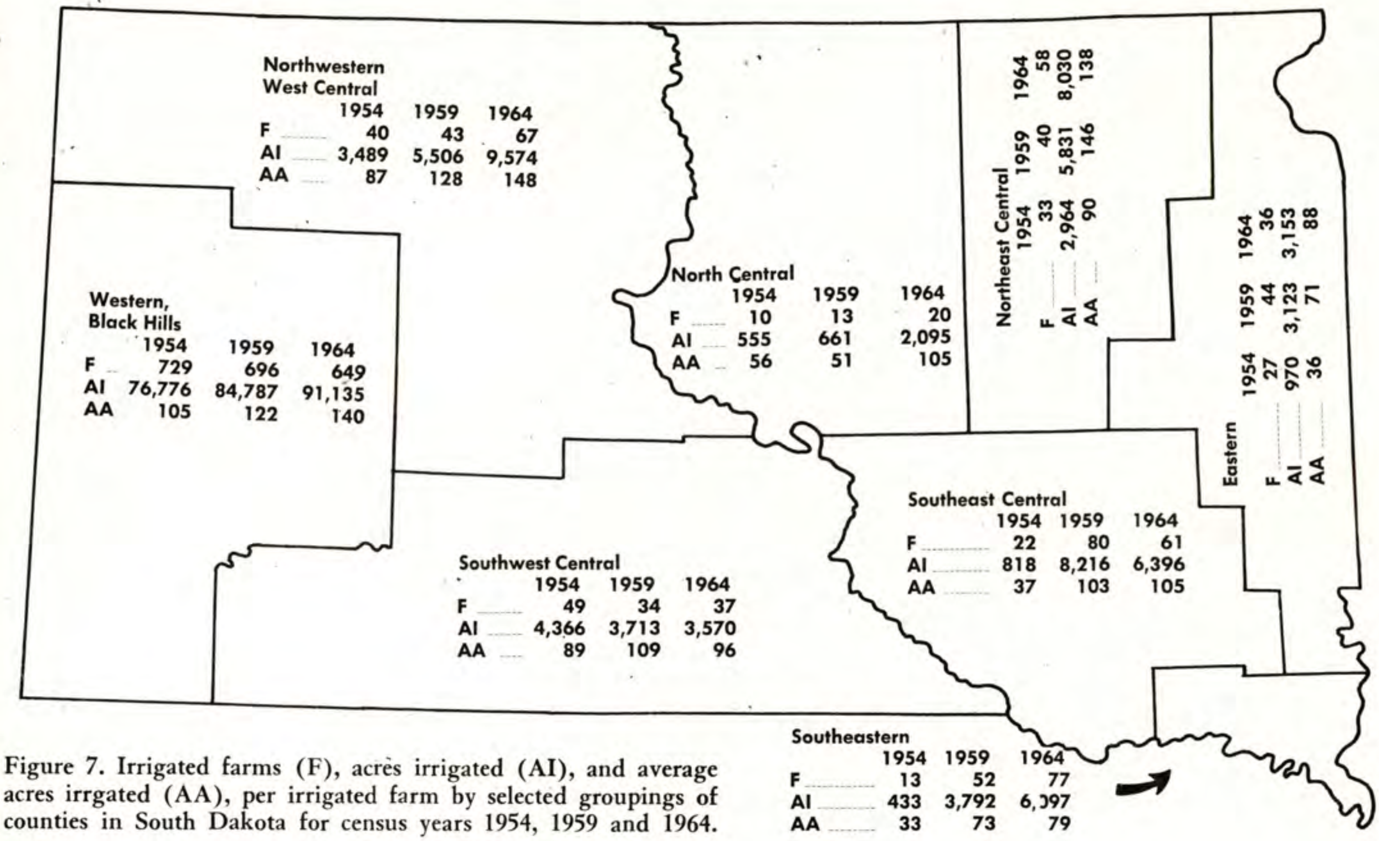


Figure 7. Irrigated farms (F), acres irrigated (AI), and average acres irrgated (AA), per irrigated farm by selected groupings of counties in South Dakota for census years 1954, 1959 and 1964.

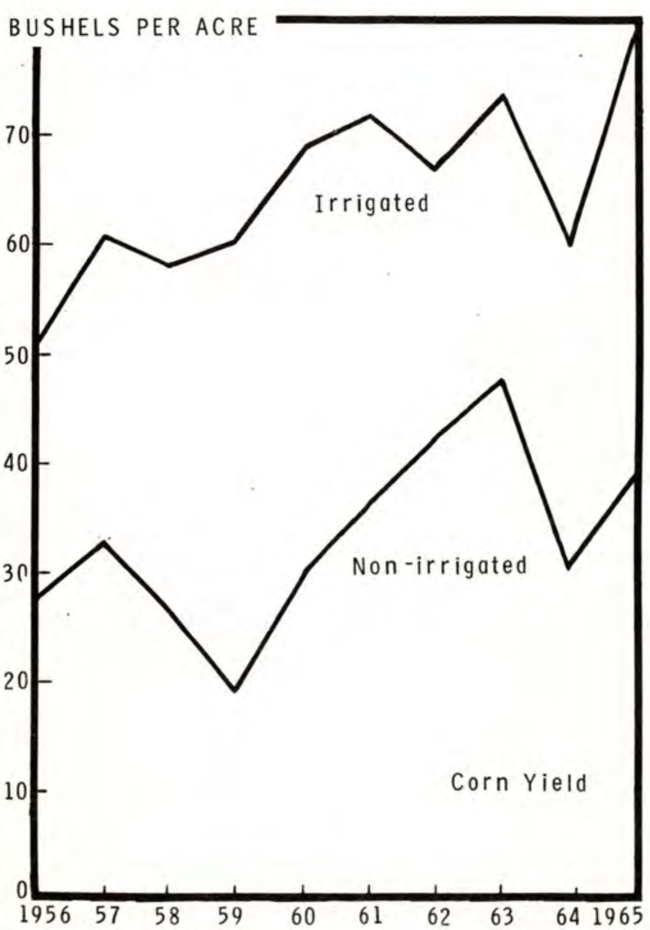
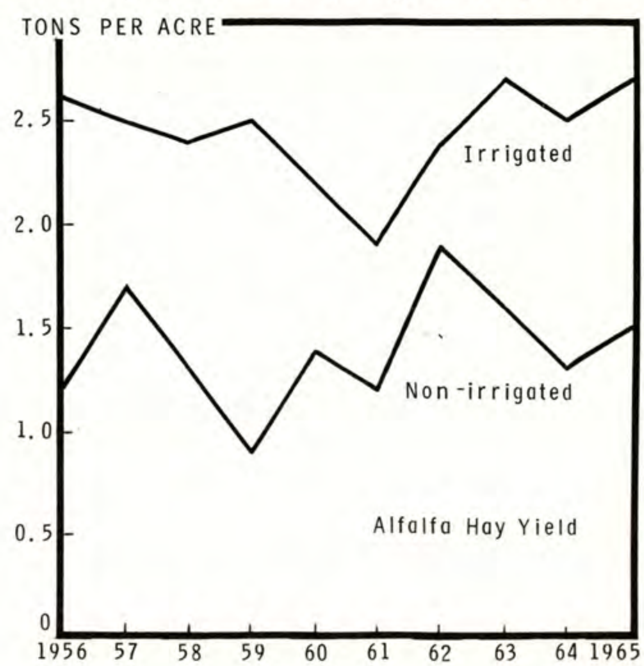


Figure 8. Corn yield averages for total irrigated and non-irrigated harvested acres in South Dakota, 1956-1965. (Source: Crop and Livestock Reporting Service reports).

Figure 9. Alfalfa hay yield averages for total irrigated and non-irrigated harvested acres in South Dakota, 1956-1965. (Source: Crop and Livestock Reporting Service reports.)



(concluded with Fig. 10, next page)

In New Experimental Hybrids . . .

Stalk and Root Rot Resistance

With **C. M. Nagel**, head, Plant Pathology Department

TWENTY dollars more an acre for your corn?

Could be—if you prevent two major corn diseases which cause lodging. Stalk and root rot diseases cut a costly swath in southeastern South Dakota last year.

Help in the battle against stalk and root rot may be available soon from new, resistant plant materials in final stages of testing by the Agricultural Experiment Station.

Laboratory isolations from diseased stalks show the major cause of lodging to be Fusarium rot, a fungus common throughout the Corn Belt in most years. The disease weakens stalks, causing breakage and lodging.

Data from 130 plots at the Southeast South Dakota Experiment Farm near Centerville in 1967 show that "healthy" corn yielded an average of 15½ bushels per acre more than "diseased" corn. Losses ranged from 8.8% in experimental plots with 10,000 plants per acre to 16.3% for 16,000 plants per acre. Yield data on losses actually are conservative because plants called "healthy" were probably not entirely disease-free.

Taking all factors into consideration, estimates place total loss from stalk and root rot under last year's conditions at nearly 21½ bushels an acre on 100-bushel-an-acre corn. That would amount to better than $20 an acre.

In research at Centerville with 69 of the 3-way experimental hybrids having varying degrees of root and stalk rot resistance, out of the 11 highest yielders, 10 are new experimental 3-way hybrids. These experimental hybrids are a little too early for the Centerville-Beresford area and probably would be best for a general area to the northward, between Centerville and Dell Rapids.

Several hundred of the new inbred lines with disease resistance have been re-cycled for development of later maturities for use in future hybrids. Results from eastern part of the state indicate that many of these hybrids also possess considerable drought resistance, a very important factor often associated with root rot.□

Irrigation . . . from page 25

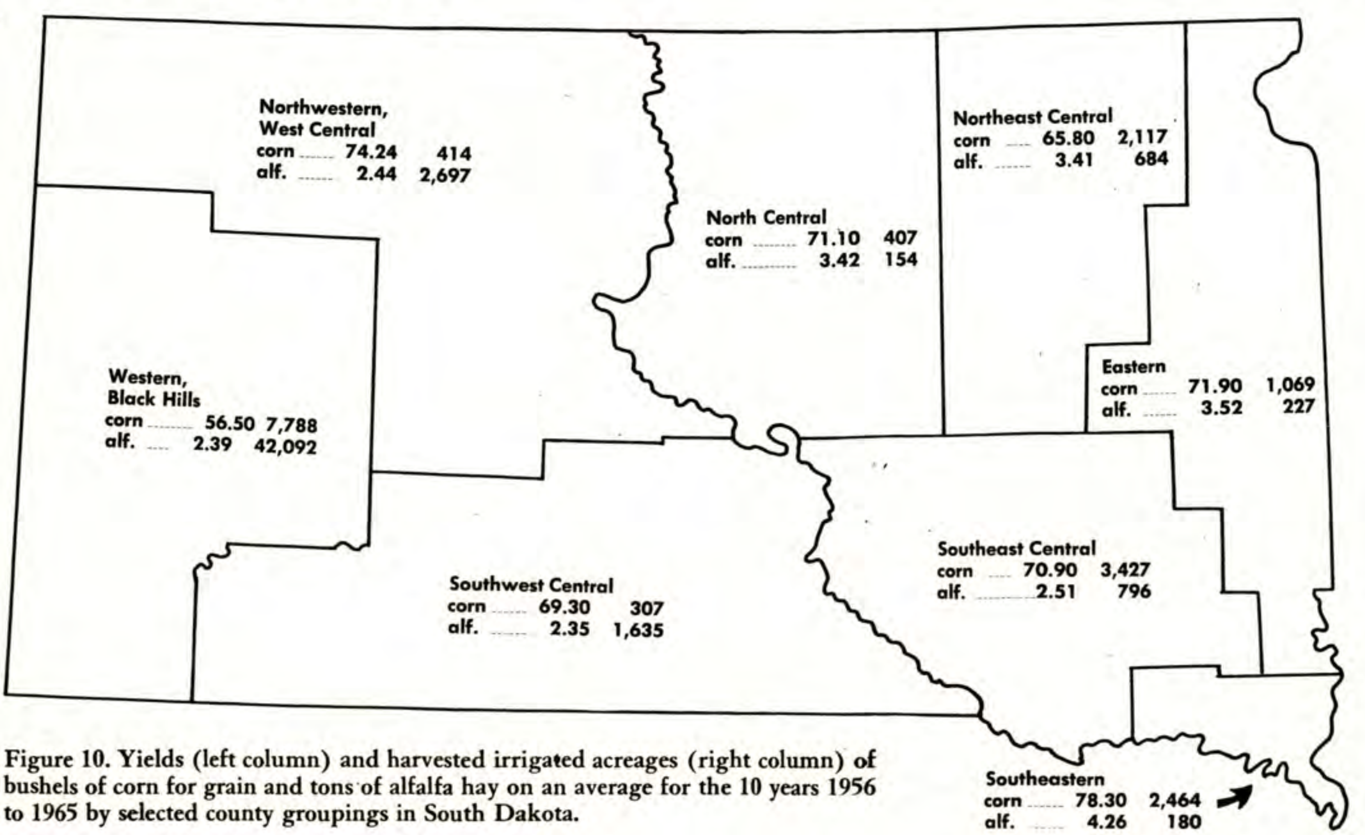
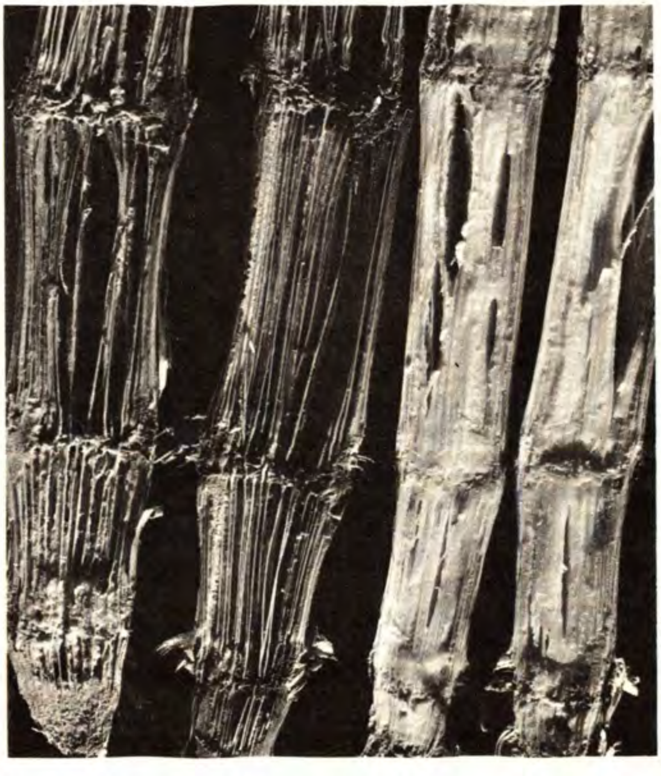


Figure 10. Yields (left column) and harvested irrigated acreages (right column) of bushels of corn for grain and tons of alfalfa hay on an average for the 10 years 1956 to 1965 by selected county groupings in South Dakota.

This is the way too much of the corn in southeastern South Dakota looked in the fall of 1967 as a result of stalk breakage and lodging due to stalk and root rot diseases. These are commercial hybrids grown in Agricultural Experiment Station research plots at Centerville.

Experimental 3-way hybrids with stalk and root rot resistance (no stalk breakage) developed by plant pathologists of the Agricultural Experiment Station. These plots are only a short distance from other plots with heavy lodging. This photo and the one with lodged corn were taken the same day.

This is what stalk and root rot does. The severe shredding of pith and disintegration of joints in two diseased stalks (left) weaken the plant. Stalk rot resistant plants (right) show pith intact and joints with little disease damage.



Progress Report

Starter Fertilizer Research

By **Fred E. Shubeck,** professor, Agronomy Department, and **Burton E. Lawrensen,** assistant superintendent, Southeast South Dakota Experiment Farm, Centerville

KEY to

FERTILIZER TREATMENTS

For Charts 1-6, next page

(N-P-K amounts expressed in elemental form)

1 = 0+0+0.
2 = 12+23+17 sideband.
3 = 3+6+5 pop-up, 80 lb/A N plowed down.
4 = 3+6+5 pop-up, 9+17+12 broadcast and plowed down, 80 lb/A N broadcast and plowed down.
5 = 12+23+17 sideband, 80 lb/A N broadcast and plowed down.
6 = 12+23+17 and 80 lb/A N all broadcast and plowed down.

WHAT'S NEW on starter fertilizers in South Dakota?

For one thing, it's the use of a new starter term, known as "pop-up."

The term "pop-up" is frequently used for a small amount of starter fertilizer placed near or in direct contact with seed to stimulate early season growth. It is especially effective when the early part of the growing season is cool.

Based on preliminary research in the southeastern part of the state, it is advised to "go slow" and use care with starters—especially pop-up. Pop-ups may not give the anticipated grain yield responses and they possibly will even retard germination which results in decreased stands.

In experimental plots, pop-up treatments maintained a small maturity advantage in corn all through the growing season from a faster early growth, to earlier silking, to earlier maturity in the fall. This was on a soil medium in nitrogen and phosphorus and high in potassium. It is emphasized that these results are for only one year.

Too much pop-up can cause problems. Research as yet hasn't determined exactly how much is best. Amount used in 1967 was 3 pounds of nitrogen, 6 pounds of phosphorus and 5 pounds of potassium (elemental form) per acre. Applying such a small amount of fertilizer under field conditions is difficult because most applicators were not built to accurately apply such small amounts.

So far, preliminary investigations indicate that the method of starter fertilizer application (pop-up or sideband) has not been so terribly important as long as the proper amount was applied.

GERMINATION

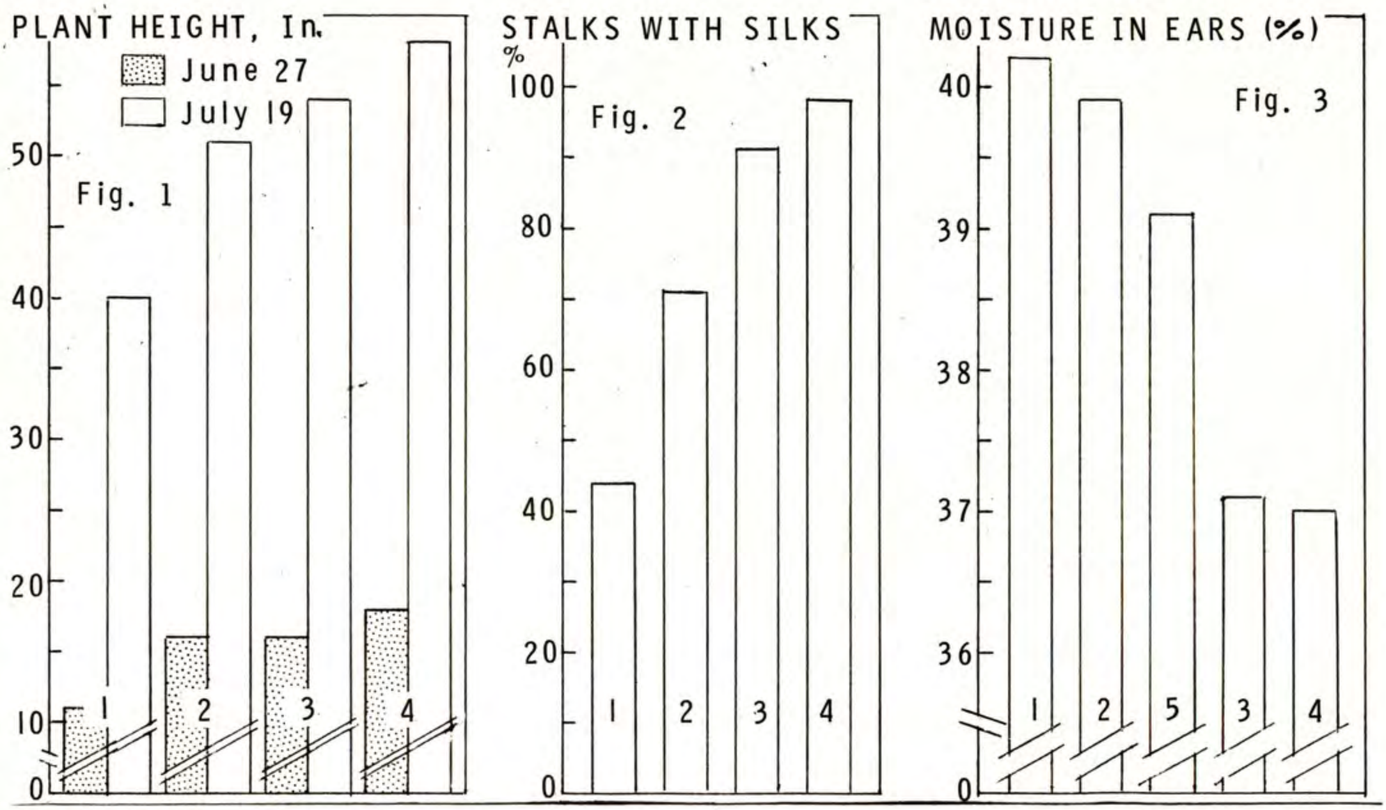
Some experiences in 1967 show that "handle with care" should be observed in using pop-ups. Because of small amounts involved, it is easy to put on too much. Several farmers who tried it last year were convinced they ended up with decreased stands for this reason. When used as pop-up, nitrogen and potassium are more injurious to germination than phosphorus. Only 8 pounds per acre of these two potentially injurious fertilizers (3 pounds elemental nitrogen, 5 pounds elemental potassium) were used as pop-up in experimental plots.

The exact, safe amounts that can be applied have not been determined. Several factors must be considered:

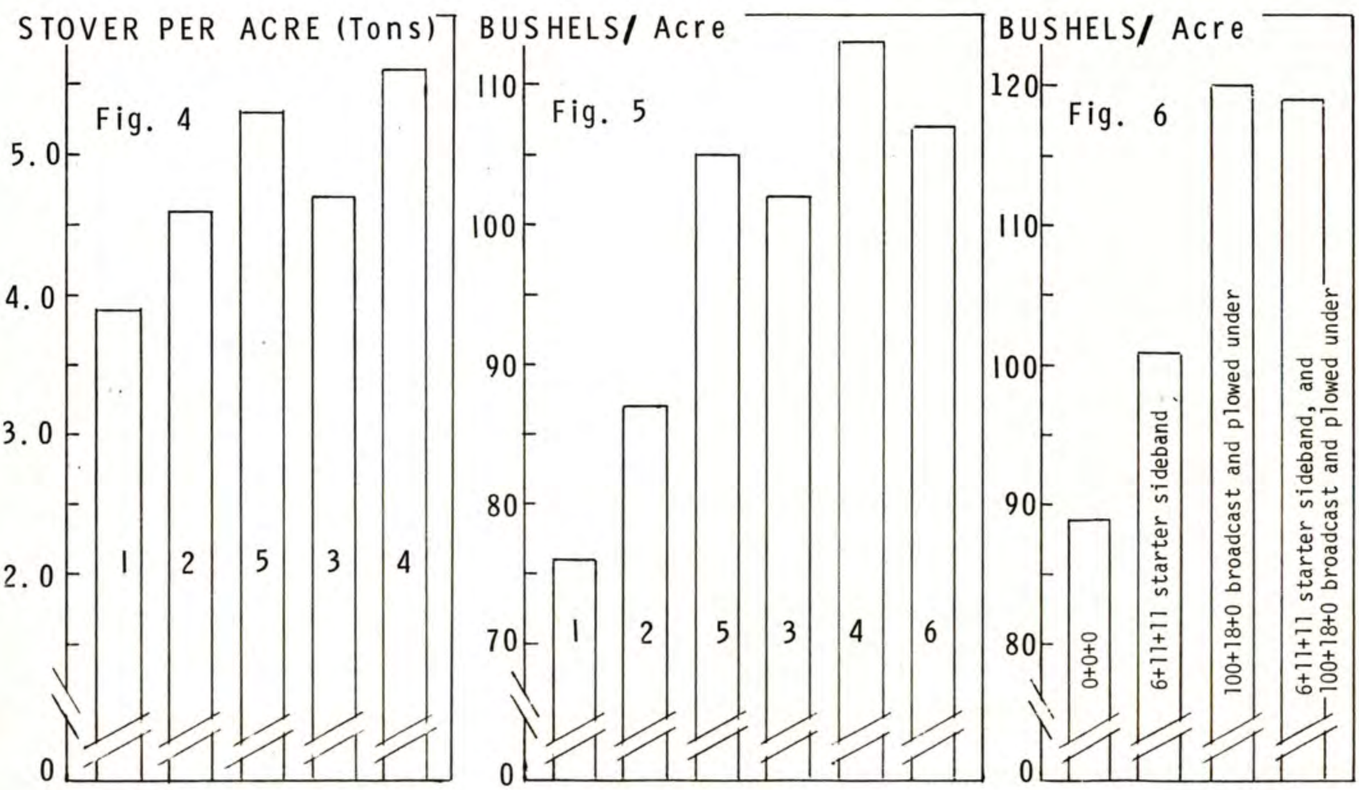
- Soil texture. More pop-up can be safely applied on a silt loam than on a sandy soil because a silt loam has a greater adsorptive capacity.
- Fertilizer composition. SDSU researchers applied 5 pounds of potassium in the form of potassium chloride without injury but some researchers suggest that chloride salts be avoided. Higher rates may be risky, especially in a dry year. In South Dakota research, monoammonium phosphate was used. In other states researchers suggest that fertilizers which yield free ammonia or that contain urea and diammonium phosphate should not be used as pop-up or reduced stands might result.
- Soil moisture. A heavy rain soon after planting (and pop-up application) will leach some nitrogen and potassium away from seed and minimize damage. Phosphorus would not leach as much but it isn't as damaging to germination anyway. Only trouble here, how do you know if it's going to rain!

EARLY GROWTH

At Centerville in 1967, corn emerged at about the same time for all fertilizer treatments, including pop-up. By June 27, 42 days after planting, corn was 5 to 7 inches taller in plots with pop-up plus supplemental plowdown fertilizer than in the unfertilized check (Figure 1.) By July 19 corn in pop-up plus plow down treatments was 14 to 18 inches taller than the unfertilized check. Pop-up treatments were not especially outstanding for increasing growth compared to a sideband



Effect of pop-up, sideband starter and nitrogen plow down fertilizer on: (above) Figure 1—early corn growth; Figure 2—per cent of stalks with silks showing August 3, 1967; Figure 3—percent moisture in ears at harvest; (below) Figure 4—tons of stover at harvest, 70% moisture; Figure 5—yield of 15½% moisture corn. Figure 6 (below)—Effect of starter fertilizer on corn yield when additional fertility is plowed down.



treatment spaced 2 inches to the side and slightly below the seed.

For this particular trial, pop-up didn't "pop" the corn out of the ground any sooner. The effect on growth of both pop-up and sideband starter was greater after corn was about a foot high.

SILKING DATE

All experimental fertilizer treatments had a speeding up effect on silking dates (Figure 2.) By August 3, 27% more stalks had silks showing in the sideband starter plots than in the unfertilized check. At the same time nearly all stalks (98%) had silks in plots with pop-up plus supplemental plow down fertilizer.

EAR MOISTURE

Pop-up treatments in experiments last year maintained a small maturity advantage all through the growing season including earlier maturity in the fall (37% ear moisture at harvest). Although ear moisture difference (Figure 3) for pop-up was small, about 3% lower than the check, it might allow selection of a 3- to 5-day later and larger hybrid with greater yield potential. Theoretically starter fertilizers are more effective in cool seasons. Since 1967 was one of the coolest growing seasons in years, the 3% lower ear moisture advantage would be near the expected maximum on a similar soil with medium nitrogen and phosphorus and high potassium supplying ability.

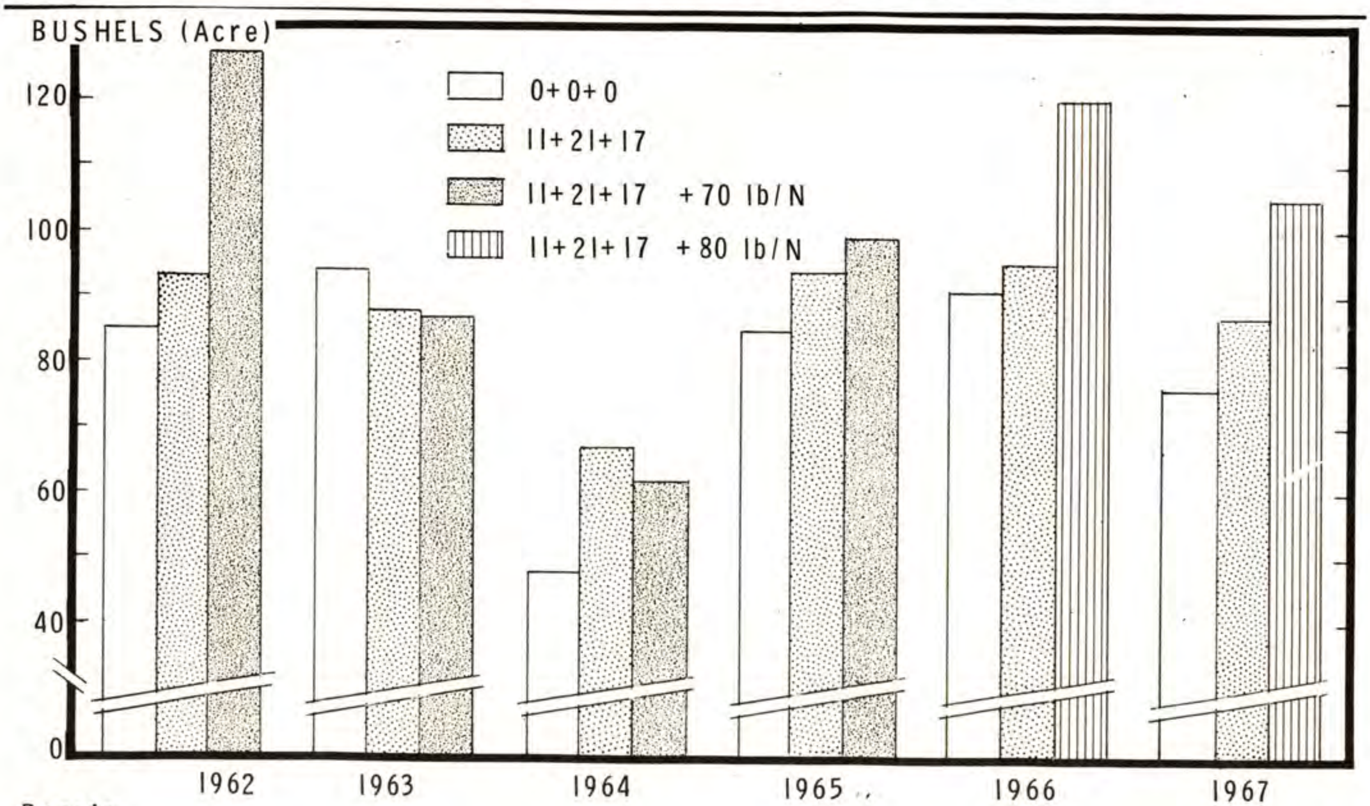
STOVER YIELDS

More forage was produced by sideband starter plus nitrogen plow down treatment than in plots where a quarter of this amount of starter was applied as pop-up plus the nitrogen plow down treatment (Figure 4). Plots with the fastest early corn growth usually had more tons per acre of forage at harvest. Greatest increases were in plots that received plow down nitrogen in addition to the starter.

CORN YIELD

In these 1-year (1967) results, *(concluded bottom next page)*

Figure 7. Effect of sideband starter (11+21+17) and sidedressed nitrogen on yields of corn.



	1962	1963	1964	1965	1966	1967
Precip. Dep.*	+8.91	-3.15	-1.47	+6.98	+1.05	-4.92
Temp. May	+4.4	-1.0	+1.8	+1.7	-3.8	-5.2
Dep.* June	-2.7	+1.8	-1.7	-0.3	-0.1	-2.1
Planted	M 14	M 8	M 7	M 12	M 19	M 16

*Departures calculated progressively from 10-year previous average in 1962 through 15-year average in 1967.

Progress Report

Narrow Row Corn Research

By **Fred E. Shubeck**, professor, Agronomy Department, and **Burton E. Lawrensen**, assistant superintendent, Southeast South Dakota Experiment Farm, Centerville

WHAT'S NEW in narrow row corn in South Dakota?

Last year (1967) provided an opportunity to measure effectiveness of narrow rows when growing conditions were not as favorable as the two preceding years.

Here is what Agricultural Experiment Station research results from southeastern South Dakota last year indicate:

- Narrow rows helped to minimize the harmful effects of insufficient moisture on yield at higher plant populations.
- The combination of narrow rows and high plant populations was most successful in years with above average rainfall.
- Research with narrow row corn has pointed to a further refinement, termed "equidistant" planting, a relatively new concept which offers opportunities for improving yields. As the term indicates, kernels are planted so that all adjacent plants in and between rows will be the same distance apart. Even an approximation to equidistant planting has some advantages.
- For one year's results, drilling in 40-inch rows gave higher yields than checking in 40x40-inch hills. Drilling approximates equidistant planting more closely than checking in hills. Weed control is a must.
- To take full advantage of equidistant planting in a good corn year, a combination of narrow rows and

Starters . . . from page 30

starter alone increased yield of corn dried to No. 2 basis but highest yields came when supplemental nitrogen was applied in addition (Figure 5). When about a quarter of the basic starter rate (one-fourth of 12+23+17) was applied as a pop-up and 80 pounds of nitrogen per acre plowed down, yields were almost as much as when the total basic starter rate was applied in a sideband plus the 80-pound-nitrogen plowed down.

When the basic starter rate was split into two applications with about a fourth applied as pop-up and three-fourths plowed down with the 80 pounds of nitrogen, yields were increased a little more than the above treatments. This treatment also yielded slightly more corn than the same total amount of fertilizer all plowed down. Results might change in another year under different climatic conditions.

Results for starter and sidedressed nitrogen for a 6-year period are charted in Figure 7. Nitrogen was sidedressed when corn was 12 to 18 inches high.

Response to starter alone was variable. In two years (1963 and 1966) of the six, yield increases from starter alone were small or none at all. An attempt was made to show the relationship of precipitation, air temperatures and response to starter fertilizer. Only one year (1963) of the six had warmer than average June temperatures. This year also had 3.15 inches below average rainfall and no increase in yield due to starter fertilizer. Three years (1963, 1964 and 1967) had below average rainfall. This is not the only criterion that determines starter fertilizer response because out of the three years, two gave a response and these two years had below average June temperatures. The variability of the above results demonstrates the need for more research relating environment to crop response.

A small response to starter was noted for 1966. Annual rainfall and June temperature were fairly close to the 14-year average. There is some question about putting as much as 21 pounds of phosphorus (48 pounds of P_2O_5 or 100 pounds of 11-48-0 an acre) on a soil with a medium phosphorus supplying ability. Work is continuing to see if this practice can influence yields adversely by interfering with zinc uptake or formation of tillers.

PLOW DOWN PLUS STARTER

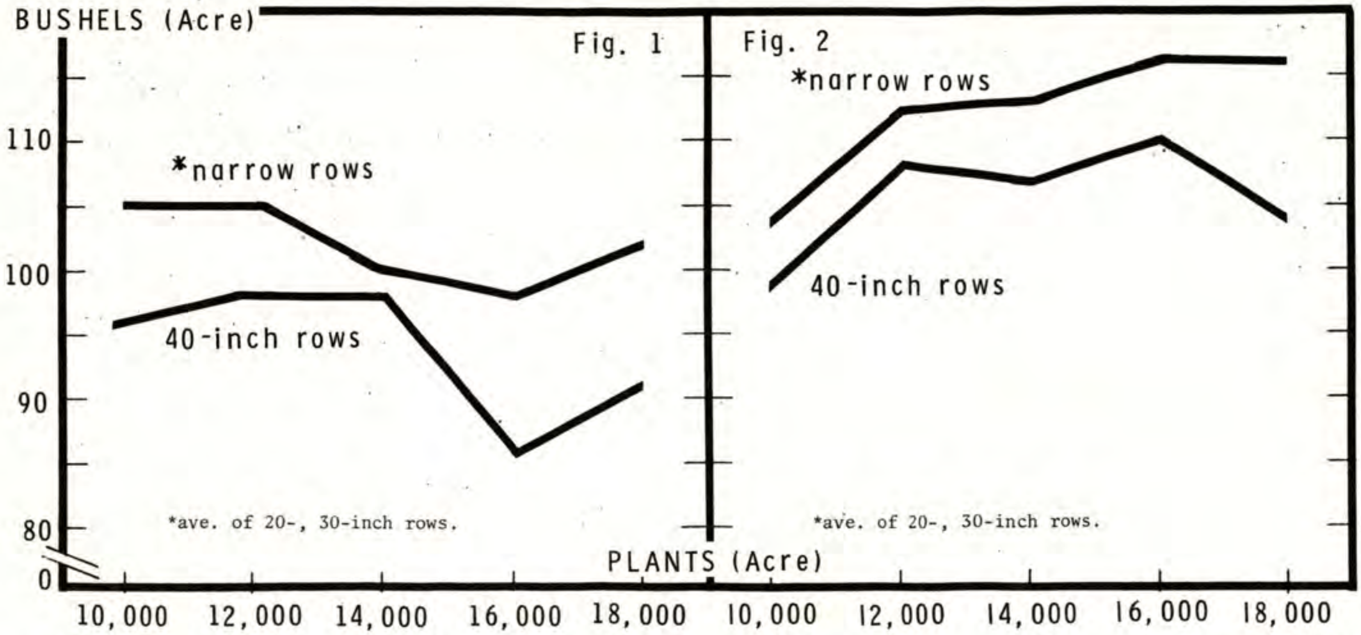
Figure 6 shows value of starter fertilizer when additional fertility was plowed down. These results were obtained in a separate and different experiment from those mentioned above and are for one year, 1967. Last year was a good year to observe the results of this practice because the weather conditions were favorable for a response from starter and yield increases were obtained in this experiment when starter was applied alone. The check plot (not fertilized) yielded 89 bushels per acre on this soil which was relatively high in fertility. Starter alone increased corn yields 12 bushels per acre above the check plot.

When corrective amounts of fertilizer were broadcast and plowed down without a starter, yield went up to 120 bushels an acre. When starter was applied in addition to the plow down treatment, there was no increase in yield. Therefore, when sufficient amounts of fertilizer are plowed down, the value of additional fertilizer applied as a starter can be questioned. Again, bear in mind that results were obtained in a year quite favorable for a starter fertilizer response.

Results from other states are not all in agreement with these findings in South Dakota.

EQUIPMENT

Because such a small amount of pop-up is needed, it must be measured more accurately. This is difficult with many fertilizer applicators. One method is to use insecticide spreaders to meter the fertilizer. Belt applicators with fertilizer measured to nearest gram per row were used in experimental plots. Liquid fertilizer and a squeeze pump is another satisfactory method of metering pop-up. ☐



(Above) Effect of row spacing and plant populations on: Figure 1 (left)—yield of full season corn in 1967; Figure 2 (right) —yield of full season corn, 2-year average 1965 and 1966.

a moderate increase in plant populations is necessary.

However, changing row spacing is not for you unless you can be sure equipment is available for the entire season to handle narrower rows.

NARROW ROWS AND RAINFALL

Last season's rainfall at the Southeast South Dakota Experiment Farm near Centerville was below average in March, April and May. Rainfall was good in June and in the critical months of July and August. Total rainfall was about 5 inches below average but cool temperatures resulted in more effective use of moisture.

Narrow row (20- and 30-inch averages) yields in 1967 held fairly constant as populations increased from 10,000 to 18,000 plants per acre but yields from 40-inch rows decreased with the two highest (16,000 and 18,000) plant populations (Figure 1). In years with above average moisture (1965 and 1966) the higher narrow row yields leveled off at about 116 bushels an acre for the two highest populations while yields from 40-inch rows decreased at 18,000 (Figure 2). Results from 20-inch and 30-inch rows were averaged because differences between them were small compared with 40-inch rows.

Three years of results indicate that relatively high plant populations are desirable when narrow rows are used. Rainfall in those 3 years ranged from about 6 inches above average to 5 inches below average. However, the year with low total rainfall had near normal moisture in the critical months of July and August.

HIGHER POPULATIONS IN LOW-LYING AREAS

Yields were considerably higher in another 1967 experiment in a lower-lying area sometimes flooded by runoff water. In this experiment, with extra water, a large hybrid at 19,000 plants per acre gave only a 5-bushel increase over 13,275 plants per acre when both were drilled in 40-inch rows (Figure 3). In a geographical area such as eastern South

(Below, left) Figure 3—Effect of plant populations on corn yield when drilled in 40-inch rows, 1967, (100 pounds N and 18 pounds of P broadcast and plowed down).

(Below, right) Figure 4—Effect of planting method on corn yield, 1967, (40-inch rows and 13,275 plants per acre, both planting methods treated with 100 pounds N and 18 pounds of P per acre broadcast and plowed down).

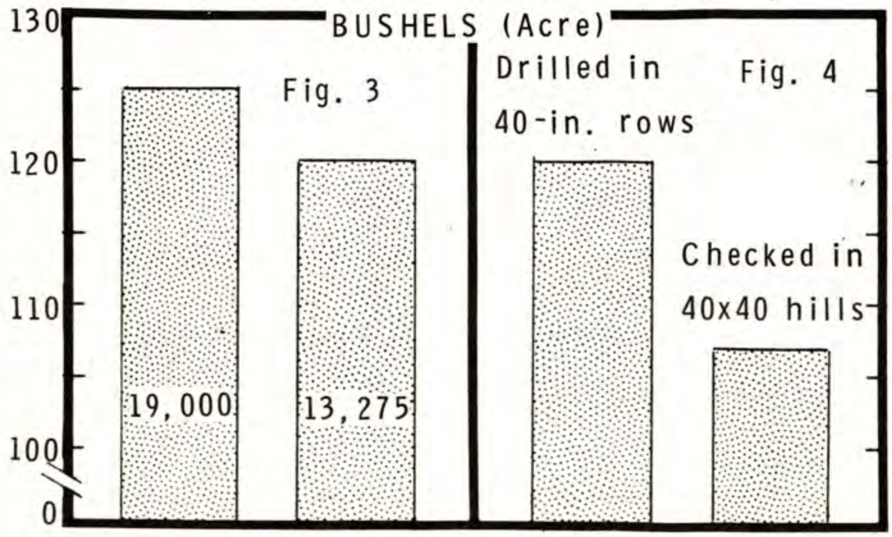
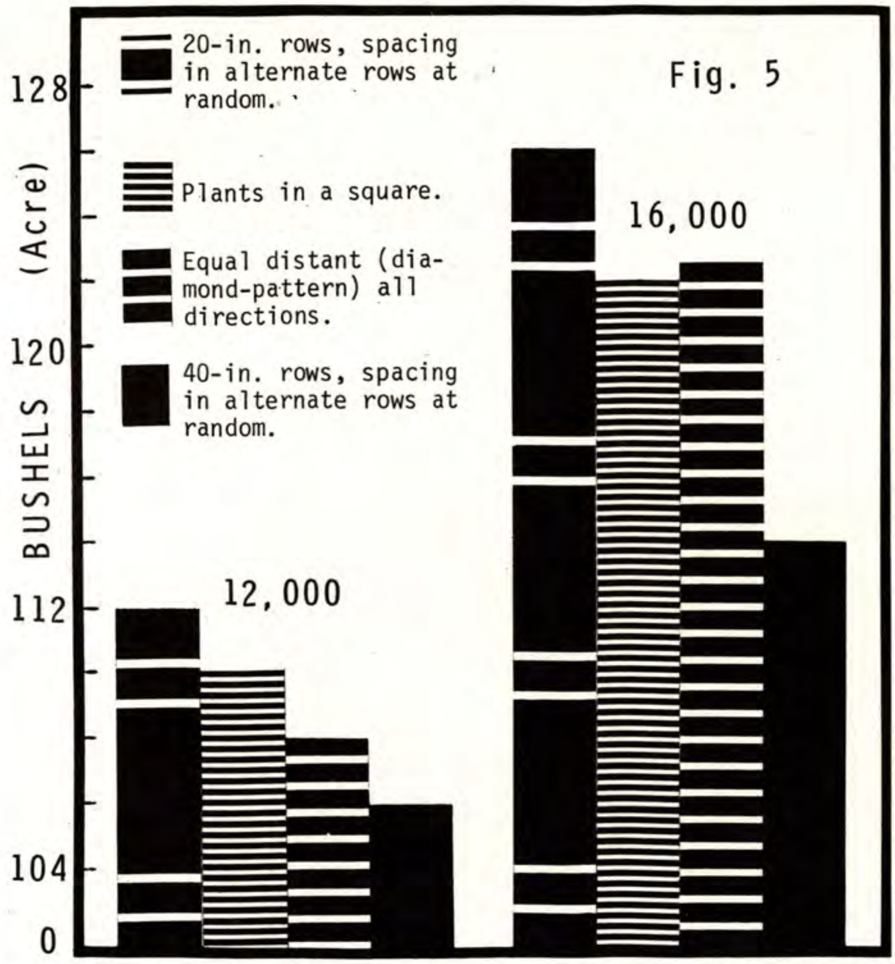


Figure 5—Effect of corn plant populations and spatial arrangements on grain yield, 1966.



Dakota subject to occasional droughts, this looks like a big risk to take for only a 5-bushel increase. If rows had been planted in narrower spacings, risk would have been somewhat reduced and yields might have been greater, judging from previous research.

WEED CONTROL AND SPACING

Drilling in 40-inch rows resulted in higher yields (120 bushels an acre) than checking in 40x40-inch hills (107 bushels) as shown in Figure 4. This is in accordance with previous investigations which indicated that spreading plants out in a more nearly equal distance arrangement (as in drilling in this experiment) is better than crowding them together in hills or in widely spaced rows. The idea is that more leaf area gets direct sunlight so carbohydrate production, measured as bushels of grain produced, is greater. Weed control in this experiment was excellent.

The catch is weed control. A 6-to-8-inch band of foxtail in drilled corn would mean lower yields because foxtail takes large quantities of moisture and fertilizer from soil and can overcome advantages of a more equal distance spacing. If weed control is a problem, it probably would be better to use a band spray of weed control chemicals over the drilled rows or to check the corn and cultivate both ways.

EQUIDISTANT PLANTING

Yield advantages have been found when corn was planted in experiments so that each stalk was the same distance from adjacent stalks both within and between rows. (See also "Corn Plant Spacing and Populations," South Dakota *Farm & Home Research,* 1967 Winter Issue). But this planting arrangement would be difficult under field conditions.

However, a reasonably close approximation to equidistant planting can be obtained by drilling 16,000 plants per acre in 20-inch rows so that location of seed approaches a diamond-shaped pattern. (Agricultural engineers at SDSU are investigating methods of adjusting planters so that alternate units plant on a staggered pattern 50%, or halfway, behind the other units).

This approximate equidistant planting pattern yields about as well as the most exact equidistance arrangement (Figure 5). The results indicate: narrow the rows to take full advantage of yield increases afforded by approximating equal distance spacing □

Many Ways to Use New Dairy Product

Develop Dairy Spread

The new low-fat, all-dairy spread developed by South Dakota State University (see also article page 3) marks a significant research achievement by these two SDSU dairy scientists.

Shirley W. Seas (seated) and Kenneth R. Spurgeon have been working on the product at the Agricultural Experiment Station since 1962. Seas first visioned a low-priced dairy spread while an undergraduate at SDSU in the 1950's. He has worked mainly on manufacturing and processing while Spurgeon investigated ingredient details.

They will continue to be available for assistance as processors investigate large-scale manufacturing and marketing procedures.

VERSATILITY is one main characteristic of the new low-fat dairy spread developed at South Dakota State University.

It is not a butter and not a cheese. But the new product can be used in ways similar to both of these. It is an all-dairy spread. And when it is available commercially sometime in the future you might even find other uses. Dairy food processors were provided processing and ingredient details early in April.

How would you like one product you can take out of your refrigerator (it does require refrigeration for best preservation) and use it:

- As a spread on bread, toast, rolls or muffins.
- As a sauce on hot vegetables.
- As a sandwich base.
- On waffles or to make waffle batter.
- On baked, boiled or mashed potatoes.
- On roasting ears.
- Blended with confectioner's sugar to make frostings.
- In cookies or brownies.
- In yeast rolls and baking powder biscuits.
- In banana bread.
- In soups.
- To baste barbecued chicken.

In using the product you will find that it spreads readily directly after removal from refrigerator or at room temperature. It has good moisture-holding ability which means frostings, cakes, cookies and other baked goods made with it tend to stay moist and soft. It does not separate but tends to remain somewhat creamy on hot cakes, waffles, corn-on-the-cob and other hot foods.

It can be stored 90 days or longer at ordinary refrigeration temperatures.

For those who are weight conscious: the product has about half the fat content of margarine or butter but much more milk protein, milk sugar and essential minerals and about 60% of the calories of those higher-fat products.

Research has shown the spread should not be used for frying or heating alone for pouring on vegetables or on pop corn. □

With Irrigation . . .

50 TONS OF POTATOES

By **Paul Prashar,** associate professor,
Horticulture-Forestry Department

High yield of potatoes is the result of a combination of about 40 factors. Some of these factors cannot be controlled under field conditions while others are more or less controlled by the growers.

The most controllable factors which affect potato yields are moisture, disease and insect damage, days grown, size and quality of seed pieces, variety, timely operation and fertilizers. Top potato yields come only from integrating these many factors. There is little difference in relative cost of producing small and large yields.

Based on the past 2 years of experience, it appears that potatoes in the Redfield area under irrigation can produce a bumper crop in a normal year. Last year a yield of 986 bushels (60 pounds/bushel) per acre was obtained as compared to 350 bushels average yield in this area.

50 Tons an Acre Possible

It is calculated that a yield of 50 tons of potatoes per acre under irrigation in Redfield may be possible if relationships of *variety, fertilizer* and *water* are properly integrated.

In the past 2 years Kennebec potatoes were planted about May 15 in rows 42 inches apart with plants 12 inches apart within the rows. Various rates and types of fertilizers were used to determine the need of a fertilizer for maximum yield in 1967 as shown in the accompanying table.

The analysis of variance of data indicates no significant difference between the replications and fertilizer treatments. This could be explained by referring to the results of the soil test which was taken before planting and application of various fertilizers. The soil test taken before planting showed: nitrogen 105 pounds, phosphorus 120 pounds, and potassium 590 pounds per acre. The potatoes followed alfalfa which was heavily fertilized. This amount of fertilizer is enough to produce a good crop of potatoes. This is why additional fertilizer in this experiment did not show increase in potato yield.

Experiments for 1968

From 1967 results it is proposed that in 1968 to obtain a yield of 50 tons per acre the planting should be done early, using closer spacing between the rows and plants within a row, and a different variety. To support this high plant population, the soil test indicates that 1,500 pounds of 8-16-8 per acre should be used. Later in the season the crop should be side dressed with 300 pounds of ammonium nitrate.

Other crops such as onions and asparagus have great possibilities in the Redfield area because of the nature of the soil, climate and future availability of water. These crops, as well as potatoes, all can be harvested with machinery and will fit better in farm practices in the Redfield area. Cool season crops such as cabbage and cauliflower also have good possibilities there. □

Yield of Potatoes in pounds from each harvested plot (4 rows 30 feet long)

	I	II	III	IV	V	VI	VII	VIII
	Treatment per acre							
Replication	0-0-0	0-46-240	134-0-0	134-0-240	134-46-0	134-92-0	134-92-240	134-92-480
I	508	508	529	505	531	486	506	477
II	473	473	511	470	567	466	523	539
III	438	438	506	486	488	529	506	524
IV	422	422	481	461	470	502	416	507
Average	460	460	506	490	514	496	488	512

New Institute of Irrigation Technology

Establishment of an Institute of Irrigation Technology at South Dakota State University has been announced by President H. M. Briggs following approval by the Regents of Education.

The Institute, in the planning stage for several months, will coordinate the expanding teaching, research and extension programs of SDSU to achieve the greatest benefit of the total irrigation effort of South Dakota.

The Institute is described by officials as an organizational unit to combine current and future irrigation work by all departments of the College of Engineering, the College of Agriculture and Biological Sciences, the Experiment Stations and Extension Services of these colleges.

No new state funds will be required for the Institute during the current fiscal year, according to Dr. Briggs. A full time director will be hired in the future. Operation of the Institute is to be through allocations to existing colleges and departments of SDSU and any cooperating institutions. Nearly all staff of the Institute will be housed in and hold academic rank in currently organized departments.

The Institute's major purposes are:

- To train irrigators and irrigation technicians as well as professional agriculturists and engineers.
- To provide research-extension team approach to obtain information about all aspects of irrigation.
- When desirable, to seek financial support for research and training from outside sources such as private industry or Federal agencies.
- To make research results and training material readily available to farmers, ranchers and others.

The Institute as planned will involve the talent and assistance of persons from throughout the state as well as the technical staff at SDSU. A state advisory committee will include representatives from major agencies and organizations concerned with irrigation or related activities. A coordinating committee of SDSU personnel is to function as an advisory group to the Institute director regarding type of research and educational programs, priorities and evaluation.

Direct supervision of the new organization will be under a policy committee consisting of the President of SDSU, Dean of Agriculture and Biological Sciences, Dean of Engineering, and Director of the Water Resources Institute. General supervision of the Institute will be by a director. A current SDSU faculty member will serve as acting director until a director is named.

"South Dakota State University has been a center for irrigation and related research and education in South Dakota for many years," according to a joint statement by Duane Acker, Dean of the College of Agriculture and Biological Sciences, and John E. Lagerstrom, Dean of the College of Engineering. "Establishment of the Institute of Irrigation Technology provides the logical approach to coordinate all educational, research and extension personnel and facilities to give South Dakota the most efficient TOTAL effort in exploiting its irrigation potential."□

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